



COMMONWEALTH of VIRGINIA

Chesapeake Bay Nutrient and Sediment Reduction Tributary Strategy for the Shenandoah and Potomac River Basins

Public Comment Draft
April 2004

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I. Introduction and Background

This *Chesapeake Bay Nutrient and Sediment Reduction Tributary Strategy for the Shenandoah and Potomac River Basins* reflects a continuation of Virginia's commitment to improving local water quality and the water quality and living resources of the Chesapeake Bay. With its roots in the 1983 creation of the Chesapeake Bay Program the strategy builds on previous efforts and looks to shape actions in a large and diverse watershed over the next seven years and beyond. The reduction goals are far greater than any set before.

Developed as a partnership between natural resources agencies and local stakeholders, this strategy provides options for meeting ambitious reductions in nitrogen, phosphorus and sediment and outlines future actions and processes needed to maintain these levels in the face of a growing population and changing landscape.

The challenges in developing a strategy for such a diverse watershed were many. This watershed stretches from the Allegheny Mountains to the Bay itself. It encompasses the state's most productive farmlands, its most populous suburbs and commercially viable tidal waters. Its stakeholders are as diverse as the landscapes they call home.

A successful nutrient and sediment reduction strategy will have significant impacts on water quality in the creeks, streams and rivers that feed the Shenandoah and Potomac Rivers. Likewise, along with strategies being developed for other Bay tributaries in Virginia, Maryland, Pennsylvania, West Virginia, New York and Delaware, they will have a cumulative effect on the waters and living resources of the Chesapeake Bay.

The Bay is North America's most biologically diverse estuary, home to more than 3,600 species of plants, fish and animals. Approximately 348 species of finfish, 173 species of shellfish and more than 2,700 species of plants live in or near the Bay. It also provides food and shelter for 29 species of waterfowl, and more than one million waterfowl winter annually in the basin.

The plight and status of these species show that they will respond to the proper management practices. And that much still needs to be done.

A history of restoration

In the early 1980s, the Chesapeake Bay was a resource in severe decline. Water quality degradation played a key role in the decline of living resources in Bay and its tidal tributaries.

In 1983 the governors of Virginia, Maryland and Pennsylvania were joined by the mayor of Washington, D.C., the U.S. EPA administrator and the chairman of the tri-state legislative Chesapeake Bay Commission to sign an agreement working toward the restoration of the Chesapeake Bay. This agreement created a multi-jurisdictional, cooperative partnership known as the Chesapeake Bay Program that would proceed through cooperative and shared actions.

An over abundance of nutrients was identified as the most damaging water quality problem facing the Bay and its tributaries. High levels of nutrients, primarily phosphorus and nitrogen,

over-fertilize the Bay waters, causing excess levels of algae. These algae can have a direct impact on submerged aquatic vegetation by blocking light from reaching these plants. More importantly, these algae have an indirect effect on levels of dissolved oxygen in the water. As algae die off and drop to the bottom, the resulting process of biological decay robs the surrounding bottom waters of oxygen, needed by oysters, fish, crabs and other aquatic animals.

The 1987 Bay Agreement recognized the role nutrients played in the Bay's problems and committed to reducing annual nitrogen and phosphorus loads into Bay waters by 40 percent by 2000. It was estimated that a 40 percent reduction would substantially improve the problem of low dissolved oxygen, which affects the Bay and many of its tributaries.

Nutrient reduction tributary strategies initiated

In 1992, Virginia joined her Chesapeake Bay Program partners in determining that the most effective means of reaching that water quality goal would be to develop tributary-specific strategies in each Chesapeake Bay river basin.

The tributary strategy approach is born of the realization that our actions on the land have a major impact on the waters into which they drain. This is particularly true in the 64, 000 square mile Chesapeake Bay watershed, where the ratio of land to water is 14:1. This approach also allowed stakeholders in each basin to address its mix of pollutants from point sources (i.e. wastewater treatment plants and industrial outflows) and nonpoint sources (runoff from farms, parking lots, streets, lawns, etc.).

Late in 1996 Virginia released the ***Shenandoah and Potomac River Basins Tributary Nutrient Reduction Strategy***. The result of more than three years of work, the 1996 strategy was the first important step toward reaching our 40 percent nutrient reduction goal in the Shenandoah and Potomac River basins.

Developed cooperatively with local officials, farmers, wastewater treatment plant operators and other representatives of point sources and nonpoint sources of nutrients in the basin, the strategy set a realistic commitment of reducing nitrogen and phosphorus by approximately 37 percent before the end of the year 2000. As a result of the strong support for this grass-roots approach, the 1997 Virginia General Assembly adopted the Water Quality Improvement Act to provide cost-share funding for implementation of tributary strategies.

Virginia's local governments, farmers, businesses and citizens have been very successful in implementing the ***1996 Shenandoah and Potomac Tributary Strategy***. With a combination of a strong stewardship ethic, and financial assistance under the Water Quality Improvement Fund, the people of the Shenandoah and Potomac watersheds met most of the 1996 strategy's reduction commitments.

Chesapeake 2000, A Watershed Partnership

While progress was being made in removing nutrients from the waters throughout the Chesapeake Bay watershed as the result of tributary strategies, nutrient enrichment remained a problem in the Bay's tidal waters. Beginning in 1998, the U.S. Environmental Protection Agency

proposed implementation of a TMDL (Total Maximum Daily Load) regulatory program under Section 303(d) of the Clean Water Act to address nutrient-related problems in much of Virginia's Chesapeake Bay and tidal tributaries. In May 1999, EPA included most of Virginia's portion of the Bay and several tidal tributaries on the federal list of impaired waters based on failure to meet standards for dissolved oxygen and aquatic life use attainment.

In June 2000, members of the Chesapeake Executive Council signed a new comprehensive Bay Agreement. *Chesapeake 2000, A Watershed Partnership* is seen as the most aggressive and comprehensive Bay agreement to date. Designed to guide the next decade of Bay watershed restoration, *Chesapeake 2000* commits to "achieve and maintain the water quality necessary to support the aquatic living resources of the Bay and its tributaries and to protect human health." Meeting this commitment through a continuation of the Bay Program's cooperative approach also alleviates the need for regulations to meet the same standards.

A living resources based approach

The new Bay agreement set out a process for achieving its water quality commitments that included setting increased nutrient reduction goals and the first Bay wide sediment reduction goals.

This cooperative effort has resulted in nutrient reduction goals that are much more protective than those agreed to in the past. Bay Program partners have agreed to base their success on the attainment of water quality standards, not simply pollution load reductions. These standards strive to meet established criteria for the Bay's designated uses. Bay partners chose designated uses based on living resources' habitat needs – shallow water, open water, deep water, deep channel and migratory and spawning areas.

For the first time, partners developed criteria that take into account the varying needs of different plants and animals and the various conditions found throughout the Bay. The criteria are:

- **Water clarity** – which ensures that enough sunlight reaches underwater bay grasses that grow on the bottom in most shallow areas.
- **Dissolved oxygen** – which ensures that enough oxygen is available at the right time during the right part of the year, to support aquatic life, including fish larvae and adult species.
- **Chlorophyll a** – the pigment contained in algae and other plants that enables photosynthesis. Optimal levels reduce harmful algae blooms and promote algae beneficial to the Bay's food chain.

In addition to being the focus for the reduction goals or allocations for tributary strategies, these criteria will serve as the basis for the revision of water quality standards for Virginia's tidal waters. This regulatory action is taking place simultaneously to the tributary strategy process. A notice of intended regulatory action (NOIRA), the first step in the regulatory process to amend water quality standards, was published in the Virginia Register on November 17, 2003. The Department of Environmental Quality (DEQ) is using a participatory approach, to more fully involve the public, in development of the new/revised tidal water quality standards. A Technical Advisory Committee of interested stakeholders has been formed and is meeting monthly. A set

of draft water quality standards is expected for presentation to the State Water Control Board early this summer, with a request to release them to the public for review and comment. Final state adoption of the standards is scheduled by the end of 2005, to become effective in early 2006, after approval by the U. S. Environmental Protection Agency. More information on this process can be found at <http://www.deq.state.va.us/wqs/pdf/NOIRABay.pdf>

Using computer models to determine allocations

To determine optimal nutrient and sediment allocations, Bay watershed partners developed several simulations for analysis by the Bay Water Quality Model. Each simulation, or scenario, allows Bay scientists to predict changes within the Bay ecosystem due to proposed management actions taking place throughout the Bay's 64,000-square-mile watershed.

Information is entered into the model, which details likely results of proposed management actions. These actions range from improving wastewater treatment technology to reducing fertilizer or manure application on agricultural lands to implementing improved land use programs to planting streamside forest buffers.

Next, these results are run through the model, which makes more than a trillion calculations and provides Bay scientists with a visualization of future Bay and river water quality conditions resulting from each scenario. Throughout the development of the new Bay water quality criteria, more than 70 model runs were conducted, each taking more than a week to complete.

As described above, the Chesapeake Bay Watershed and Water Quality models are powerful tools that help guide the level of effort and the types of actions needed to restore the health of the Bay and its tributaries. Understanding the strengths and limitations of these models is critical to efficiently and effectively targeting implementation efforts.

Estimating existing and future nitrogen and phosphorus loads is a key application of the watershed model. Incorporating good data and monitoring information, this model is well suited to provide these estimates.

Due, in part, to data limitations, sediment transport is simplified and sediment loads from eroding stream banks are not well captured. These limitations need to be addressed in future model versions. Moreover, these limitations need to be considered in determining ongoing implementation priorities. For example, storm water retrofits and stream restoration efforts may be more effective than is currently indicated by the model.

Regardless of certain limitations, the Chesapeake Bay Watershed and Water Quality models provide a good basis for making basing restoration decisions. Moreover, these models complement and support other tools such as water quality assessment and watershed planning activities.

At the agreed to allocations, the model predicts that we will see a Bay similar to that in the 1950s. Proposed water quality standards will be met in 96 percent of the Bay at all times, and the

remaining four percent would fall shy of fully meeting the proposed standards for only four months a year.

The resulting nutrient reduction goals, or allocations, call for Bay watershed states to reduce the amount of nitrogen entering the Bay and its tidal tributaries from the current 285 million pounds to no more than 175 million pounds per year, and phosphorus from 19.1 million pounds to no more than 12.8 million pounds per year. When coordinated nutrient reduction efforts began in 1985, 338 million pounds of nitrogen and 27.1 million pounds of phosphorus entered the Bay annually.

When achieved, the new allocations will reduce annual nitrogen loads by 110 million pounds and phosphorus by 6.3 million pounds from 2000 levels and will provide the water quality necessary for the Bay's plants and animals to thrive.

The Virginia tributary strategy approach

Using the modeling process described, Bay Program partners then determined specific allocations for each major basin. Allocations for basins that cover more than one state were divided by jurisdiction.

The new nitrogen allocation for the Shenandoah and Virginia's portion of the Potomac is 12.84 million pounds per year, compared with an estimated load of 22.8 million pounds in 2002. The allocation for phosphorus is 1.4 million pounds, compared with an estimated load of 1.96 million pounds in 2002. For sediment the allocation is 617,000 tons per year, compared with 720,000 tons in 2002. This sediment allocation does not include loading from shoreline erosion in the tidal region of the river basin.

To reach these ambitious new reduction goals, the current tributary strategy must build on what has gone before, in particular the 1996 Shenandoah and Potomac Nutrient Reduction Strategy. Many of the stakeholder groups involved in developing the previous strategy were active in working with state natural resource agency staff in crafting this nutrient and sediment reduction plan.

The strategy looks at the agricultural nonpoint source practices and wastewater treatment plant reductions that were critical to the 1996 plan to see where practices could be increased. This strategy also looks more closely at measures involving land use, urban nutrient management and stormwater management that will need to play key roles in meeting the new basin allocations.

This strategy identifies a number of nonpoint source best management practices and point source treatment levels that can be implemented to meet the Shenandoah and Potomac's allocations. However, the strategy also recognizes the need for reduction efforts to grow and expand in order to meet the 2010 goal and to maintain or cap the allocation once it is achieved. In short, implementation plans that improve local water quality throughout the Chesapeake Bay basins will be a continuous process into the future.

In this regard the strategy outlines processes that need to be developed in order to facilitate implementation between now, 2010, and beyond. There will be annual progress updates and a more thorough, Bay-wide evaluation of advancement towards the 2010 goals when an updated version of the Model becomes available in 2006.

Implementation planning as outlined in this strategy will be continually refined, addressing both point and nonpoint sources. It must identify roles and responsibilities for federal, state and local governments, the private sector, nonprofits and the average citizen. The strategy addresses the need to establish timeframes and make cost estimates, and identify potential funding sources.

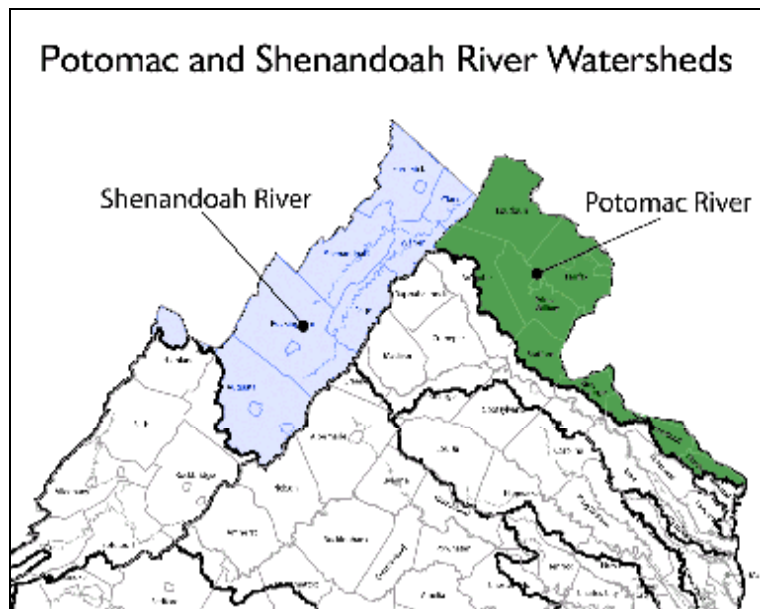
Tributary strategy implementation will be an iterative process bringing greater consideration of water quality issues to many sectors in each community as time goes by. Recognizing how land use and lifestyle can impact water quality, and finding alternatives to reduce those impacts, are objectives of tributary strategies. Marketing social change of this magnitude is a challenge that Virginia will deal with steadily using a variety of approaches. Reaching millions of individuals with these messages will take time and money, and there must be enduring popular support among the citizens and elected leaders across the watershed.

Ongoing tributary strategy implementation cannot be seen as a process that is separate from other ongoing water quality initiatives. In fact, tributary strategies should be seen as a way to connect and incorporate local water quality initiatives.

For example, many counties, some aided by local conservation nonprofit organizations, are developing local watershed management plans in their communities. These plans look at sub-watersheds of the tributary as a whole when planning new development or assessing other impacts on land and water resources. Planning at this scale reveals where individual BMPs are needed within each community in the basin. Locations for the many nonpoint sources BMPs in the tributary strategy can be determined using this technique. These local watershed plans can play key roles as a part of the implementation for a basin wide tributary strategy.

Likewise, mandated plans to restore stream segments on the federal impaired waters list, known as TMDLs (Total Maximum Daily Loads) can also be part of a larger tributary strategy. These TMDLs deal with stream segments that violate water quality standards for specific impairments such as bacteria, pH or dissolved oxygen. They do not specifically address nutrient or sediment impairments. However, the implementation plans for upstream TMDLs will also lessen nutrient and sediment loads. So, those measures included in TMDL implementation may be incorporated into the larger tributary strategy for that river basin.

II. Virginia's Shenandoah and Potomac River Basins



The Shenandoah and Potomac Fast Facts

- *Drainage in Acres:* 3,649,195 (1,768,841 in Potomac, 1,880,354 in Shenandoah)
- *Square Miles:* 5,723 (2,763 in Potomac, 2,960 in Shenandoah)
- *About 13.4 percent of Virginia's land*
- *Length:* Potomac – 383 miles (W.Va., Md., D.C., Va.)
Shenandoah – 60 miles
- *Shenandoah Headwaters* – The river's north fork originates in Rockingham County, its south fork in Augusta County. The main stem begins in Front Royal where the forks meet.
- *Counties:* 16 (Shenandoah: Frederick, Clarke, Warren, Shenandoah, Rockingham, Page, Augusta; Potomac: Arlington, Loudoun, Fairfax, Prince William, Fauquier, Stafford, King George, Westmoreland, Northumberland)
- *Cities:* Nine (Shenandoah: Staunton, Waynesboro, Harrisonburg, Winchester; Potomac: Alexandria, Fairfax, Falls Church, Manassas, Manassas Park)
- *2000 Population:* 2,333,429 (Shenandoah: 322,331; Potomac: 2,011,098)
- *Larger Tributaries:* Potomac – Occoquan River, Bull Run, Four Mile Run, Difficult Run, Quantico Creek, Aquia Creek, Potomac Creek; Shenandoah – Christians Creek, Middle River, North Fork, North River, South Fork and South River
- *Land Use:* Shenandoah – 38 percent agriculture, 59 percent forest, and 3 percent urban.
Potomac – 12 percent urban, 31 percent agriculture, 56 percent forest, 1 percent open water.

The Potomac River is often referred to as our *nation's river* because it flows through Washington D.C. – the nation's capitol. It is a shared resource between Virginia, Maryland, Washington D.C., West Virginia, and Pennsylvania. The river's watershed area, or land it drains, encompasses 14,679 square miles in four states and Washington, D.C. Virginia has the largest drainage area at 5,723 square miles, about 6 percent of the state's total land base.

The 3,063 square mile Shenandoah River watershed also feeds the Potomac. The main stem begins in Front Royal, at the confluence of the North Fork and the South Fork. The North Fork of the Shenandoah River originates in Rockingham County and the headwaters of the South Fork of the Shenandoah are in August County. The 60-mile-long Shenandoah River empties into the Potomac River at Harper's Ferry, West Virginia, and its watershed comprises almost 5 percent of the Virginia's entire Chesapeake Bay basin.

Captain John Smith explored the Potomac 1608 and found fish *"lying so thick with their heads above water, that for want of nets, we attempted to catch them with a frying pan."* Times and populations have changed greatly since then, in 2000, the entire population of the watershed was 5.25 million people, with Virginia's portion at slightly more than two million.

The Potomac runs 383 miles from its beginnings at Fairfax Stone, West Virginia, to where it joins the Shenandoah River at Harper's Ferry, then plunges dramatically to sea level at Great Falls and then meanders slowly past Washington D.C. to where it empties into the Chesapeake Bay at Point Lookout, Maryland. The majority of the watershed is covered in forests, about 57 percent, followed by agriculture at 32 percent and urban at roughly five percent. In recent years, urban land use has been increasing, with both forest and agriculture decreasing. Larger tributaries include the Occoquan River, Bull Run, Four Mile Run, Difficult Run, Quantico Creek, Aquia Creek, and Potomac Creek.

In the Shenandoah, farms still account for as much as 37 percent of land in the watershed, despite the region's growing population and proximity to urban centers. About 58 percent of the watershed is forested, 38 percent is agricultural, and nearly 3 percent is urbanized. The population of the Shenandoah River watershed in 2000 was estimated at 328,985 and a 20 percent increase in population is expected over the next 30 years. With that population increase can be expected significant change in land use patterns, especially the conversion of agricultural land to urban land.

Throughout the Shenandoah River watershed, an extensive and varied agriculture industry thrives. Corn, hay, and orchards dominate its cropland, while densely populated livestock operations including poultry, dairy, beef, and swine utilize untilled land. Several counties in the Shenandoah Valley are the top agriculture-producing counties in Virginia.

The resources of the watershed fulfill an important recreational function as well. Over 200 miles of the Shenandoah River and tributaries are designated trout-fishing waters and provide enjoyment to hundreds of fishermen each year. Also, thousands of people swim and float down the river on rafts, inner tubes, canoes, and kayaks.

The Virginia Potomac Tributary Strategy encompasses in whole the counties and independent cities of Alexandria, Arlington, Fairfax, Fairfax City, Falls Church, Loudoun, Manassas, Manassas Park, and Prince William; and substantial portions of Fauquier, King George, Northumberland, Stafford and Westmoreland. The Shenandoah strategy covers Frederick, Clarke, Warren, Shenandoah, Rockingham, Page and Augusta counties plus the cities of Staunton, Waynesboro, Harrisonburg, Winchester

The Potomac basin contains some of the most highly populated and fastest growing localities in the state, if not the nation. Changing land use patterns away from agriculture and forest and more towards urban continue to have profound impacts on wastewater treatment flows and the type of land available for best management practices available to mitigate water pollution from. While the Shenandoah basin is seeing pressure from development, farming – in particular poultry, beef cattle and dairy – is the predominant land use.

Major pollutants

As with other watersheds, major water pollutants affecting the Shenandoah and Potomac are nitrogen, phosphorus, and sediment. Many local governments and pollution experts cite both point source discharges such as municipal and industrial wastewater treatment plants and nonpoint sources such as farm and turf fertilizer overuse and misuse, insufficient farm conservation practices, failing on-site systems, even urban sprawl and uncontrolled development as the main pollutant sources. In general, the middle portion of the Potomac is dominated by point sources and urban land use loadings, while the Shenandoah and lower portion of the Potomac tend to be influenced more by agricultural, forested or mixed-open nonpoint sources.

Not all of the nutrients entering the Bay are considered to be controllable. The nonpoint source loads that naturally occur from forested areas in the basin are not considered to be part of the controllable fractions. The remaining nutrient loads both from point and nonpoint sources, that enter the Bay are considered to be “controllable” to varying degrees and can therefore be reduced through nutrient reduction practices.

Water Quality status and trends

This section presents a very general overview of selected water quality conditions in the tidal portions of the Virginia Chesapeake Bay and its major tributary basins, with a focus on the Potomac. Maps showing various trends in the basin (Figures 1-6) are located in Appendix 3.

It is difficult to adequately summarize the water quality conditions of the Shenandoah-Potomac basin in such a short document. Much more comprehensive and detailed analyses are available for each major Bay basin, and the reader is encouraged to supplement this brief status and trends information with several reports available through the DEQ Chesapeake Bay Program website at www.deq.state.va.us/bay/wqifdown.html and the DEQ Water Programs' Reports webpage at www.deq.state.va.us/water/reports.html.

Water quality conditions are presented through a combination of the current status and long-term trends for nitrogen, phosphorus, chlorophyll, dissolved oxygen, water clarity, and suspended solids. These are the indicators most directly affected by nutrient and sediment reduction strategies. Environmental information regarding other important conditions in Chesapeake Bay (e.g., underwater grasses, fisheries, chemical contaminants) are available in the 2004 biennial report, "Results of Monitoring Programs And Status of Resources", available via the webpage for the Secretary of Natural Resources at www.naturalresource.virginia.gov.

The Virginia Chesapeake Bay and its tidal tributaries continue to show environmental trends indicating progress toward restoration to a more balanced and healthy ecosystem. However, the

Bay system remains stressed and some areas and indicators show continuing degradation. Progress in reducing nutrient inputs has made measurable improvements and it is expected that continued progress toward nutrient reduction goals, along with appropriate fisheries management and chemical contaminant controls, will result in additional Bay improvements. Findings from the last 18 years (1985 through 2002) of the monitoring programs are discussed in the following sections.

Nutrients (nitrogen and phosphorus) influence the growth of phytoplankton in the water column. Elevated concentrations of these nutrients often result in excessive phytoplankton production (i.e., chlorophyll). Decomposition of the resulting excess organic material during the summer can result in low levels of dissolved oxygen (D.O.) in bottom waters. These low D.O. levels can cause fish kills and drastic declines in benthic communities, which are the food base for many fish populations. Low-D.O. waters also adversely affect fish and crab population levels by limiting the physical area available where these organisms can live.

Phosphorus: Figure 1 presents current status and long-term trends in phosphorus concentrations. Some of Virginia's Bay waters have the poorest conditions in relation to the rest of the Chesapeake Bay system. Other downstream segments of rivers are fair but the mainstem Chesapeake Bay and the upper portions of the tidal rivers have relatively good conditions.

The “watershed input” stations shown in Figure 1 provide information about the success of nutrient control efforts. Results at these watershed input monitoring stations are flow-adjusted in order to remove the effects of river flow and assess only the effect of nutrient management actions (e.g., point source discharge treatment improvements and BMPs to reduce nonpoint source runoff). Several input stations show improving concentration trends, but unfortunately a degrading trend for the Potomac watershed is still present.

Nitrogen: Figure 2 presents status and long-term trends in nitrogen concentrations. As with phosphorus, management actions to reduce nitrogen have been effective as indicated by improving trends at the Potomac River watershed input station. The improving trend of nitrogen at the watershed input station of the Potomac River as well as large reductions from point sources in the Washington, D.C. area has resulted in improving trends in several tidal areas of that river. Most of Virginia's Chesapeake Bay is also showing improving trends in nitrogen. Status of nitrogen in the upper Potomac River is worse than status in the other major tributaries (Rappahannock, York, and James) and the Virginia Chesapeake Bay.

Chlorophyll: Chlorophyll is a measure of algal biomass (i.e., phytoplankton) in the water. High chlorophyll levels are an indicator of poor water quality because they can lead to low D.O. conditions when the organic material sinks into bottom waters and is decomposed. High algal levels can also reduce water clarity, which decreases available light required to support photosynthesis in underwater grasses. High algal levels also can be indicative of problems with the food web such as decreased food quality for some filter-feeding fish and shellfish. Finally, high levels of chlorophyll may indicate large-scale blooms of toxic or nuisance forms of algae.

Figure 3 presents the current status and long term trends in chlorophyll concentrations. Parts of all of the major Virginia tributaries have poor status in relation to Bay-wide conditions. A

degrading trend in chlorophyll was detected in the upper tidal fresh portions of the Potomac, while an improving trend was observed in the lower Potomac River.

Dissolved Oxygen: Bottom dissolved oxygen levels are an important factor affecting the survival, distribution, and productivity of aquatic living resources. Figure 4 shows the current status and long term trends in dissolved oxygen concentrations. Status is given in relation to dissolved oxygen levels supportive or stressful to living resources. About half of the Virginia Chesapeake Bay and smaller portions of the tidal tributaries had only fair status. The lower Potomac River and northernmost Virginia Chesapeake Bay segments are indicated as poor or fair status, partly because of low D.O. concentrations found in the mid-channel trenches. These mid-channel trenches have naturally lower D.O. levels, but the area affected and duration of low dissolved oxygen levels has been made worse by anthropogenic nutrient inputs.

There are scattered areas of improving conditions for dissolved oxygen and no areas of degrading trends. All of the tributaries have areas of improving conditions. These improvements are a result of both the nutrient management efforts and natural factors, such as declining riverflow, which in turn has lead to naturally less nutrient inputs and concurrently higher influxes of cleaner oceanic water.

Water Clarity: Water clarity is a measure of the depth to which sunlight penetrates through the water column. Poor water clarity is an indication that conditions are inadequate for the growth and survival of underwater grasses. Poor water clarity can also affect the health and distributions of fish populations by reducing their ability to capture prey or avoid predators. The major factors that affect water clarity include: 1) concentrations of particulate inorganic mineral particles (i.e., sand, silt and clays), 2) concentrations of algae, 3) concentrations of particulate organic detritus (small particles of dead algae and/or decaying marsh grasses), and 4) dissolved substances which “color” the water (e.g., brown humic acids generated by plant decay). Which of these factors most greatly influence water clarity varies both seasonally and spatially.

Figure 5 presents the current status and long term trends in water clarity. Status of many segments within the tributaries and the Chesapeake Bay mainstem are only fair or poor. This suggests that poor water clarity is one of the major environmental factors inhibiting the resurgence of SAV growth in Chesapeake Bay. Degrading trends in water clarity were detected in segments located over a wide geographic area within the Virginia tributaries and Virginia Chesapeake Bay. These degrading trends represent a substantial impediment to the recovery of SAV beds within Chesapeake Bay. Possible causes of the degrading trends included increased shoreline erosion as a result of waterside development, loss of wetlands, increased abundance of phytoplankton, or a combination of sea level rise and land subsistence.

Suspended Solids: Suspended solids are a measure of particulates in the water column including inorganic mineral particles, planktonic organisms and detritus that directly controls water clarity. Elevated suspended solids can also be detrimental to the survival of oysters and other aquatic animals. Young oysters can be smothered by deposition of material and filter-feeding fish such as menhaden can be negatively affected by high concentrations of suspended solids. In addition, since suspended solids are comprised of organic and mineral particles that may contain nitrogen

and phosphorus, increases in suspended solids can result in an increase of nutrient concentrations.

Figure 6 presents the current status and long term trends in suspended solids concentrations. All of the major Virginia tributaries have segments that are fair or poor status. An improving trend in the flow-adjusted concentrations at the Potomac River watershed input station suggests that management actions to reduce NPS sediment loads may be having a positive effect.

III. Strategy practices and treatments

Nutrient and sediment allocations and nutrient reduction goals

The Shenandoah-Potomac strategy is one of five strategies developed for Virginia's Chesapeake Bay basins. While each basin had specific nutrient and sediment load allocations to reach, they are a part of overall Virginia Chesapeake Bay nutrient and sediment reduction goals. As the result of the efforts by state staff and stakeholders in all five basins Virginia has crafted a series of strategies that surpassed Virginia's nitrogen, phosphorus and sediment goals.

Table 1: Allocations and Scenarios by Basin and Statewide

	TN (LBS/YR)		
	2002 Progress	2010 VA Strategy	2010 Cap Load Allocation
Potomac	22,844,023	12,589,458	12,839,755
Rappahannock	7,899,245	5,309,703	5,238,771
York	7,679,383	5,362,111	5,700,000
James	37,258,742	24,518,310	26,400,000
Eastern Shore	2,122,892	948,292	1,222,317
VA TOTAL	77,804,285	48,727,874	51,400,843
	TP (LBS/YR)		
	2002 Progress	2010 VA Strategy	2010 Cap Load Allocation
Potomac	1,951,741	1,176,908	1,401,813
Rappahannock	954,358	692,870	620,000
York	749,445	538,103	480,000
James	5,952,375	3,486,427	3,410,000
Eastern Shore	227,205	86,734	84,448
VA TOTAL	9,835,124	5,981,043	5,996,261
	SED (TONS/YR)		
	2002 Progress	2010 VA Strategy	2010 Cap Load Allocation
Potomac	720,462	403,221	616,622
Rappahannock	335,183	247,000	288,498
York	126,987	97,999	102,534
James	1,174,351	791,403	924,711
Eastern Shore	22,036	8,002	8,485
VA TOTAL	2,379,018	1,547,624	1,940,849

Strategy development

As soon as nutrient and sediment allocations were received, stakeholder teams were formed in each of Virginia's major Chesapeake Bay tributary basins to guide and assist in preparing a strategy to meet the ambitious allocations. While the Shenandoah and Potomac basins are being

addressed here in one comprehensive strategy, separate tributary teams were created in both the Shenandoah and Potomac to develop strategies for both basins. This was seen as the most efficient way to develop a workable, stakeholder-driven process given the size and distinctive land uses and corresponding water quality issues found in the two basins.

While there were some very real differences in the two basins, many principles of the strategy development were similar. In both basins efforts were made to ensure that the tributary teams formed were representative of the diverse stakeholder interests of both the Shenandoah and Virginia Potomac watersheds. Team representatives include citizens, farmers, soil and water conservation districts, private industry, environmental groups, wastewater treatment plant operators, and local, state, and federal government agencies from both nonpoint and point sources of nutrient pollution. A complete listing of members and affiliations may be found in the appendix.

Team members worked with state staff to review existing conditions in their basin in recommending a mix of nonpoint source practices and point source treatment levels. In their work they considered the existing structure, responsibilities and workload of the governmental and private entities that would be involved in implementing these practices. They worked within the framework of existing state laws, regulations and authorities. Even assuming optimal funding their initial mix of practices came up short of the basin's nutrient and sediment load allocations.

State staff then took the stakeholders work and added practices and treatments using as its only restrictions existing technologies, land availability, animal units and other variables related only to the practices themselves. They did not factor in government responsibilities, infrastructure or availability of funding.

This analysis showed that it is feasible to meet the imposing allocation goals set for each basin. However, it also showed that considerable analysis of the barriers to implementation need to be explored and addressed. This document will begin that exploration in Section IV.

Scenario results

Table 2 – Shenandoah-Potomac Loads

	NITROGEN (LBS/YR) 1985 Baseline	NITROGEN (LBS/YR) 2002 Progress	NITROGEN (LBS/YR) 2010 Cap Load Allocation	NITROGEN (LBS/YR) Strategy Results	NITROGEN (LBS/YR) Strategy PS	NITROGEN (LBS/YR) Strategy NPS
VA Shenandoah	6,123,384	5,956,651	3,293,100	3,985,760	321,086	3,664,673
VA Potomac	18,120,484	16,887,372	9,546,656	8,603,698	3,242,350	5,361,344
Total VA Potomac	24,243,869	22,844,023	12,839,755	12,589,458	3,563,436	9,026,017

	PHOSPHORUS (LBS/YR) 1985 Baseline	PHOSPHORUS (LBS/YR) 2002 Progress	PHOSPHORUS (LBS/YR) 2010 Cap Load Allocation	PHOSPHORUS (LBS/YR) Strategy Results	PHOSPHORUS (LBS/YR) Strategy PS	PHOSPHORUS (LBS/YR) Strategy NPS
VA Shenandoah	1,253,441	1,144,111	664,071	608,234	59,730	548,504
VA Potomac	1,058,897	807,630	737,742	568,674	155,519	413,155
Total VA Potomac		1,951,741	1,401,813	1,176,908	215,249	961,659

	SEDIMENT (TONS/YR) 1985 Baseline	SEDIMENT (TONS/YR) 2002 Progress	SEDIMENT (TONS/YR) 2010 Cap Load Allocation	SEDIMENT (TONS/YR) Strategy Results	N/A	SEDIMENT (TONS/YR) Strategy NPS
VA Shenandoah	N/a	457,465	N/a	276,179		276,179
VA Potomac	N/a	262,997	N/a	127,042		127,042
Total VA Potomac		720,462	616,622	403,221		403,221

Table 2 presents the results Shenandoah-Potomac strategy process described above. It successfully meets the allocations with some overage for nitrogen, phosphorus, and sediment. In general, overages tend to occur as a result of certain BMPs that have an unequal effect on all three constituents.

For point sources, the primary factor advocated by the Commonwealth in selecting the appropriate nutrient concentrations for a basin was the stringency of the overall loading allocation for that basin (i.e., the higher the Tier level associated with the basin loading allocation, the more stringent the point source nutrient concentration needs to be).

An additional factor in selecting the basin-wide nutrient concentrations was the proportion of the nutrient loading within each basin attributed to point sources vs. non-point sources. In those basins where the point source loads constitute a more substantial portion of the total basin nutrient load, it is reasonable to expect the point sources to achieve a higher reduction level. Likewise, in basins where the point sources contribute a relatively minor portion of the total basin load it is not reasonable to expect them to achieve extremely low nutrient concentrations.

It also shows the nutrient and sediment cap load allocations as provided by the Chesapeake Bay Program Office in March of 2003, showing the amount of nitrogen, phosphorus, and sediment that the Potomac and Shenandoah will be allocated to discharge in to the Bay yearly in millions of pounds. These limits illustrate the pollutant amounts that are believed can safely enter the Bay from the Shenandoah- Potomac basins and still allow good habitat for Bay living resources such as fish and submerged aquatic vegetation. The table also provides information for nitrogen on

the “baseline” established in 1985 as well as the 2002 progress to date. The 1985 baseline nutrient load is the sum of both point source discharges and the nonpoint nutrient runoff, associated with 1985 land uses calculated for an average rainfall year. Although the baseline and progress numbers are very similar, it is considered progress towards “holding the line” on nutrients given the high rates of urban growth that have occurred during the 17-year period between 1985 and 2002.

The remainder of this section will further analyze the strategy by looking at the list of recommended practices and treatments. These lists are referred to as “input decks.” These input decks were submitted to modelers for use in the watershed model.

Point Source Input Deck - Shenandoah

The point source control levels proposed for the Shenandoah facilities would result in discharged loads of approximately 848,750 pounds per year of nitrogen and 94,530 pounds per year of phosphorus. Although there are many combinations of treatment levels for the affected significant facilities that could reach these load levels, for simplicity and equity the input deck assumed uniform nutrient reduction treatment at the municipal plants, and equivalent controls at the industrial plants. The municipal plants would achieve annual averages of 5.0-mg/l nitrogen and 0.5-mg/l phosphorus, coupled with projected flow levels for the year 2010; industrial plants were targeted to reduce their 2000 nitrogen and phosphorus concentrations by roughly 80 percent.

This scenario does not set load allocations for each individual plant -- what is sought is an aggregate point source load across the entire Shenandoah-Potomac basin that the plants would maintain into the future. The process for setting the individual plant allocations, and procedures to establish numerical discharge permit limits for nutrients will be decided under a rulemaking now underway to revise the State Water Control Board's "Point Source Policy for Nutrient Enriched Waters". Information on revising this regulation can be found on the DEQ Chesapeake Bay Program's webpage, at this Internet address: www.deq.state.va.us/bay/multi.html.

Table 3 - Shenandoah Point Source Tributary Strategy Input Deck

Facility	WSM Segment	Design Flow	Trib Strat	Tier 3	Proposed 2010	Tier 3	Proposed 2010
			2010 Flow	TN Conc.	TN Load (lbs)	TP Conc.	TP Load (lbs)
Coors	190	--	0.70	5.00	10,705	0.50	1,071
Dupont-Waynesboro	190	--	2.97	3.21	29,048	0.14	1,249
Fishersville	190	2.00	1.71	5.00	26,040	0.50	2,604
Luray	190	1.60	1.50	5.00	22,890	0.50	2,289
Massanutten	190	1.50	0.75	5.00	11,421	0.50	1,142
Merck	190	--	10.09	3.13	96,293	0.50	15,360
Middle River	190	6.80	5.10	5.00	77,666	0.50	8,528
North River	190	16.00	13.10	5.00	199,799	0.50	19,949
Pilgrims Pride-Hinton	190	--	0.70	10.00	21,320	2.00	4,264
Stuarts Draft	190	2.40	1.50	5.00	22,843	0.50	2,284
Waynesboro	190	4.00	2.81	5.00	42,866	0.50	4,287

Weyers Cave	190	0.50	0.40	5.00	6,091	0.50	609
Subtotal 190 =		34.80	26.87		566,982		63,637
Berryville	200	0.45	0.50	5.00	8,528	0.50	853
Front Royal	200	4.000	2.76	5.00	42,072	0.50	4,207
Georges Chicken	200	--	1.21	10.00	36,853	2.00	7,382
New Market	200	0.500	0.56	5.00	8,528	0.50	853
SIL MRRS	200	1.920	1.56	5.00	23,757	0.50	2,376
Stony Creek	200	0.600	0.39	5.00	5,939	0.50	594
Strasburg	200	0.980	0.85	5.00	12,944	0.50	1,294
Woodstock	200	0.800	0.50	5.00	7,614	0.50	761
Subtotal 200 =		8.80	6.62		146,236		18,320
FWSA-Opequon	740	8.40	6.80	5.00	103,554	0.50	10,355
Parkins Mill	740	2.00	2.10	5.00	31,980	0.50	3,198
Subtotal 740 =		10.40	8.90		135,534		13,553
Total		54.00	42.39		848,752		95,510

Point Source Input Deck - Potomac

The point source control levels proposed for the Potomac facilities would result in discharged loads of approximately 3,903,750 pounds per year of nitrogen and 166,140 pounds per year of phosphorus. Although there are many combinations of treatment levels for the affected significant facilities that could reach these load levels, for simplicity and equity the input deck assumed uniform nutrient reduction treatment at the municipal plants, with one exception. In general, the municipal plants would achieve annual averages of 4-mg/l nitrogen and 0.5 mg/l phosphorus (or lower, if required in a discharge permit), coupled with projected flow levels for the year 2010. The exception to this proposal being the Upper Occoquan Service Authority (UOSA) plant, which would discharge an annual average nitrogen level of 11 mg/l for the reasons previously described. In general, all other municipal plants would achieve annual averages of 4-mg/l nitrogen and 0.5-mg/l phosphorus (or lower, if required in a discharge permit), coupled with projected flow levels for the year 2010.

Many of the plants in northern Virginia are already subject to very stringent phosphorus control limits in their discharge permits. For purposes of the tributary strategy, the load figures used in the input deck assume achievement of the permit levels (0.18 for Potomac Embayment Plants; 0.1 mg/l for UOSA ; 0.1 mg/l for Broad Run) at each facility's current design capacity.

As with the Shenandoah, this scenario does not set load allocations for each individual plant -- what is sought is an aggregate point source load across the entire Shenandoah-Potomac basin that the plants would maintain into the future. The process for setting the individual plant allocations, and procedures to establish numerical discharge permit limits for nutrients will be decided under a rulemaking now underway to revise the State Water Control Board's "Point Source Policy for Nutrient Enriched Waters". Information on revising this regulation can be found on the DEQ Chesapeake Bay Program's webpage, at www.deq.state.va.us/bay/multi.html.

Table 4 - Potomac Point Source Tributary Strategy Input Deck

Facility	WSM Segment	Design Flow	Trib Strat 2010 Flow*	Trib Strat TN Conc	Proposed 2010 TN Load (lbs)	Trib Strat TP Conc	Proposed 2010 TP Load (lbs)
Broad Run*	220	10.00	5.00	4.00	60,914	0.10	3,046

Leesburg	220	4.85	6.00	4.00	73,097	0.50	9,137
Purcellville	220	1.00	0.42	4.00	5,117	0.50	640
Round Hill	220	0.50	0.15	4.00	1,827	0.50	228
Subtotal 220 =		16.35	11.57		140,955		13,051
DSC #1*	550	4.00	3.06	4.00	37,279	0.18	2,193
DSC #8*	550	4.00	2.85	4.00	34,721	0.18	2,193
HL Mooney*	550	18.00	15.50	4.00	188,834	0.18	9,868
UOSA*	550	54.00	35.00	11.00	1,172,598	0.10	16,447
Vint Hill	550	0.60	0.25	4.00	3,046	0.50	381
Subtotal 550 =		80.60	56.66		1,436,478		31,082
Alexandria S.A.*	900	54.00	37.94	4.00	462,217	0.18	29,604
Arlington*	900	40.00	35.29	4.00	429,932	0.18	21,929
Noman-Cole*	900	67.00	53.50	4.00	651,782	0.18	36,731
Subtotal 900 =		161.00	126.73		1,543,931		88,265
Blue Plains (VA Share)*	910	47.73	44.40	4.00	540,632	0.18	26,205
Subtotal 910 =		47.73	44.4		540,632		26,205
Quantico*	970	2.20	1.38	4.00	16,812	0.18	1,206
Subtotal 970 =		2.20	1.38		16,812		1,206
Aquia*	980	6.50	5.60	4.00	68,224	0.18	3,563
Colonial Beach	980	2.00	0.85	4.00	10,355	0.50	1,294
Dahlgren SD	980	1.00	0.36	4.00	4,386	0.50	548
NSWC-Dahlgren	980	0.72	0.43	4.00	5,239	0.50	655
Widewater STP*	980	0.50	0.10	4.00	1,218	0.18	274
Subtotal 980 =		10.72	7.34		89,422		6,335
Totals =					3,768,518		166,143

* TP load determined by the design flow times the TP permit limit

Nonpoint Source Input Deck – Shenandoah and Potomac

In general, where a range of percents is given, the first number is for the Shenandoah basin and the second for the Potomac basin. For the agriculture source category, the BMPs in the input deck focused on animal waste management systems, land conversion BMPs such as riparian forest buffers on cropland, hay and pasture (10-15percent of available acres converted to forest buffers depending on basin) and grass buffers on cropland (15-25 percent of available acres converted to grass buffers depending on basin). Other land conversion BMPs that were targeted included wetland conversion and tree planting (five percent of hay and pasture planted to trees for both basins). These land conversion BMPs have a greater effect on nitrogen, phosphorus, and sediment reductions with higher rates of pounds reduced per acre. Also, stream protection practices (off-stream watering with fencing, off stream watering without fencing, and off-stream watering with fencing/rotational grazing were targeted due to there high reduction potential.

The agronomic practices of conservation tillage, cover crops, nutrient management and farms plans were maximized, with 90 percent of the cropland in cover crops and 95 percent in conservation tillage in both basins. Farm plans were applied to 95 percent of the cropland, hay land and pasture acres in both basins. Nutrient management was applied to 90 percent of the cropland and 95 percent of the hay acres in both basins. These practices are very cost effective and unlike the land conversion BMPs, multiple practices can be applied to a given acre, which maximizes the nutrient and sediment reductions.

The BMPs targeted for the mixed open land use included forest buffers, wetlands restoration, and tree planting with 8-20 percent of the available mixed open acres being restored to forest buffers, five percent restored to wetlands, and 5-10 percent planted to trees. Nutrient management planning was applied to 95 percent of the mixed open acres in both basins.

For the urban source category the stormwater BMPs that were targeted included wet ponds and wetlands, infiltration and filtering practices. These practices are more desirable than dry detention ponds and dry extended ponds because of higher nutrient removal. Forest buffers were applied to 8-15 percent of the pervious urban acres and 5-10 percent of the pervious urban acres were planted to trees. Urban nutrient management was applied to 95 percent of the pervious urban acres in both basins after accounting for the land conversion practices mentioned above.

Forest harvesting practices were applied to the forest land use category. The acres treated by forest harvesting practices were based on reported data provided by the Virginia Department of Forestry.

The BMPs that were applied to the septic source category for both basins included connection to public sewer, septic tank pumpouts, and septic denitrification systems. The Chesapeake Bay Program provided projections as to the number of septic systems in operation by 2010. A septic tank pump out rate of 75 percent was used to calculate the number of pumpouts. The sewer connection totals were based on actual numbers reported by localities, and generally a 10 percent conversion to septic denitrification was applied.

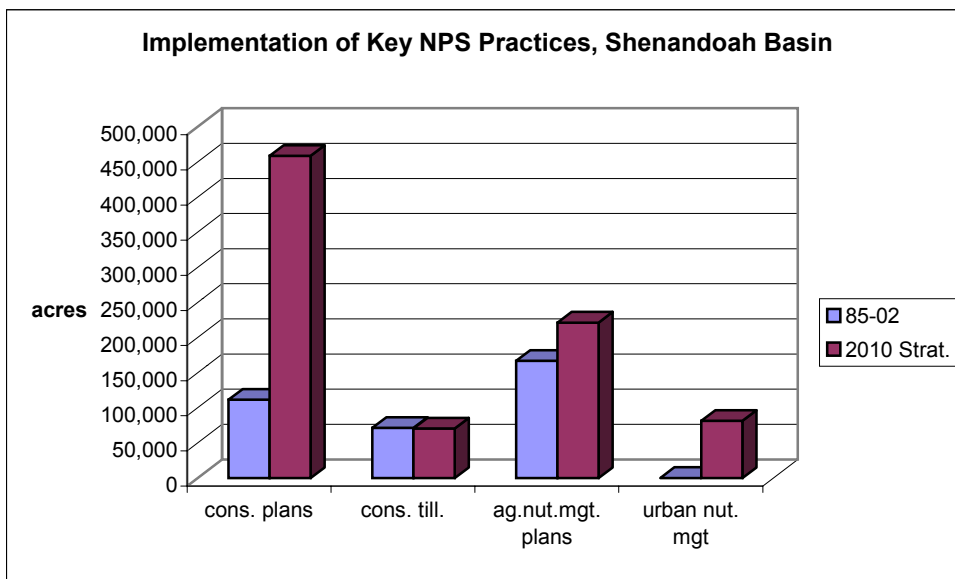
Table 5 - Virginia Shenandoah and Potomac Basin Non-point Source Input Deck

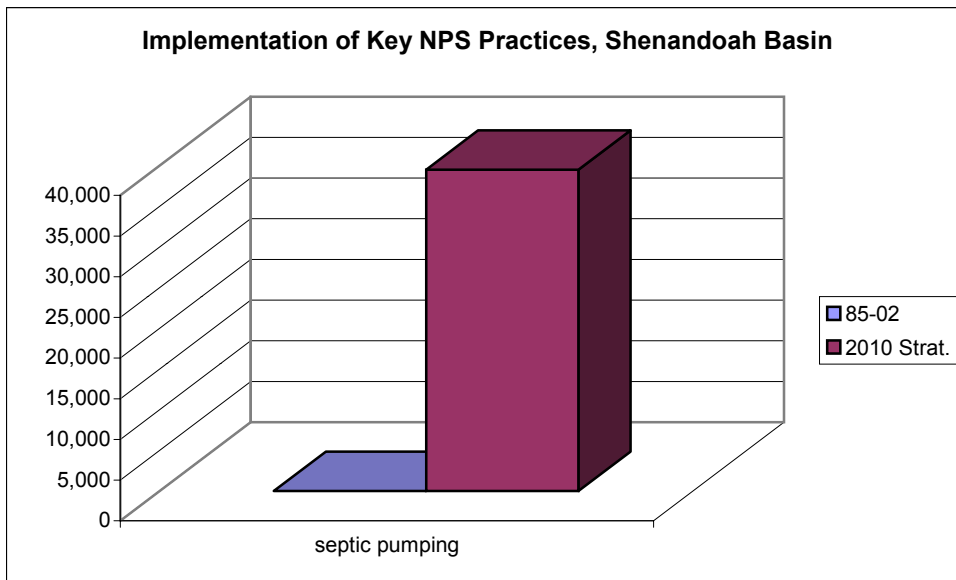
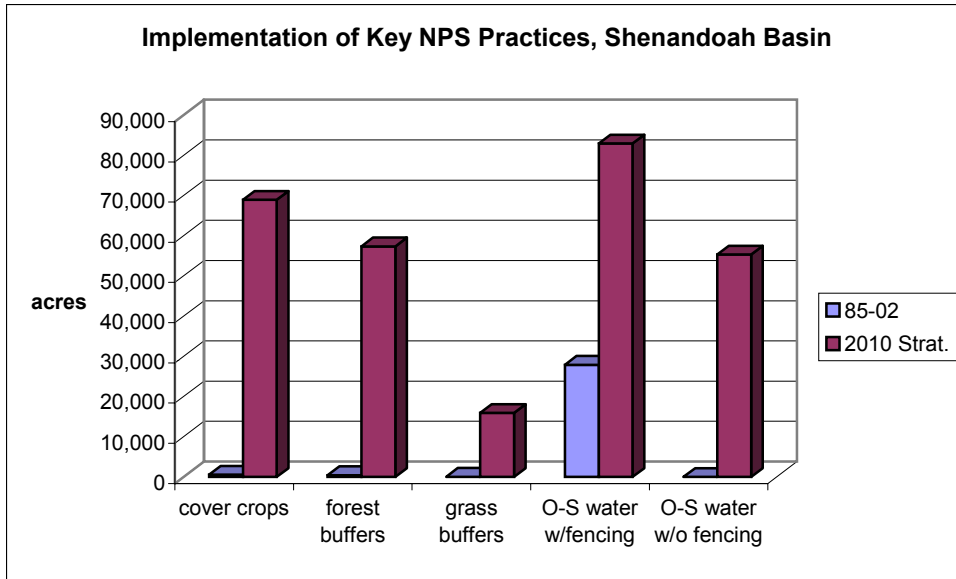
	Units	Potomac VA	Shenandoah VA	Total
<i>Agricultural BMPs</i>				
10% Livestock Manure Transport	lbs exported			
20% Poultry Litter Transport	lbs exported			
30% Poultry Phytase				
Animal Waste Management (Manure Acres)	systems	28	672	700
Carbon Sequestration (Hi)	acres	0	0	0
Carbon Sequestration (Low)	acres	0	0	0
Conservation Plans (Hay)	acres	76,895	140,762	217,657
Conservation Plans (Hi)	acres	2,216	2,116	4,332
Conservation Plans (Low)	acres	49,772	66,823	116,595
Conservation Plans (Pasture)	acres	126,333	248,838	375,171
Conservation-Tillage	acres	49,772	70,535	120,307
Cover Crops (Hi)	acres	2,216	2,116	4,332
Cover Crops (Low)	acres	47,152	66,823	113,975
Forest Buffers (Hay)	acres	16,188	14,219	30,407
Forest Buffers (Hi)	acres	13,098	10,606	23,704
Forest Buffers (Low)	acres	0	0	0
Forest Buffers (Pasture)	acres	24,934	32,528	57,462

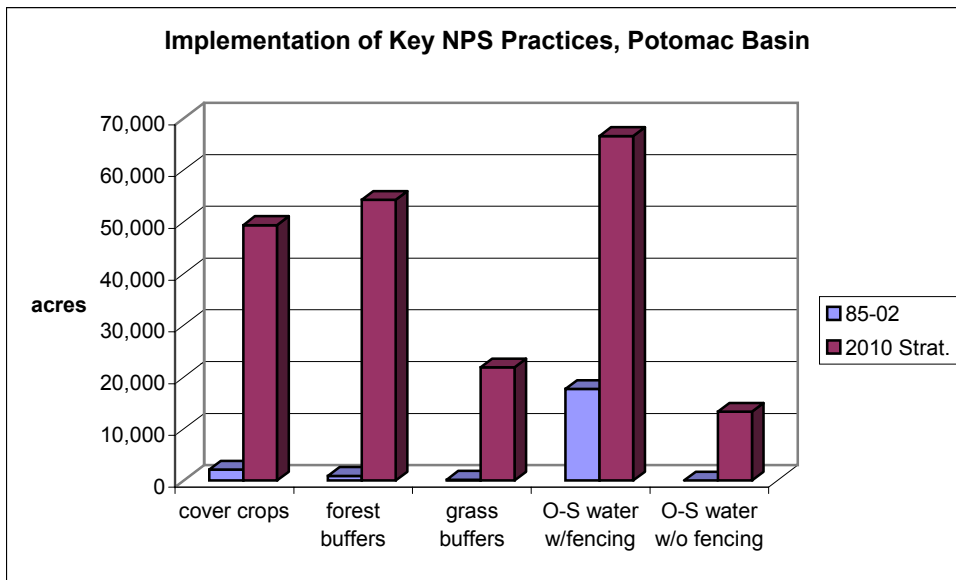
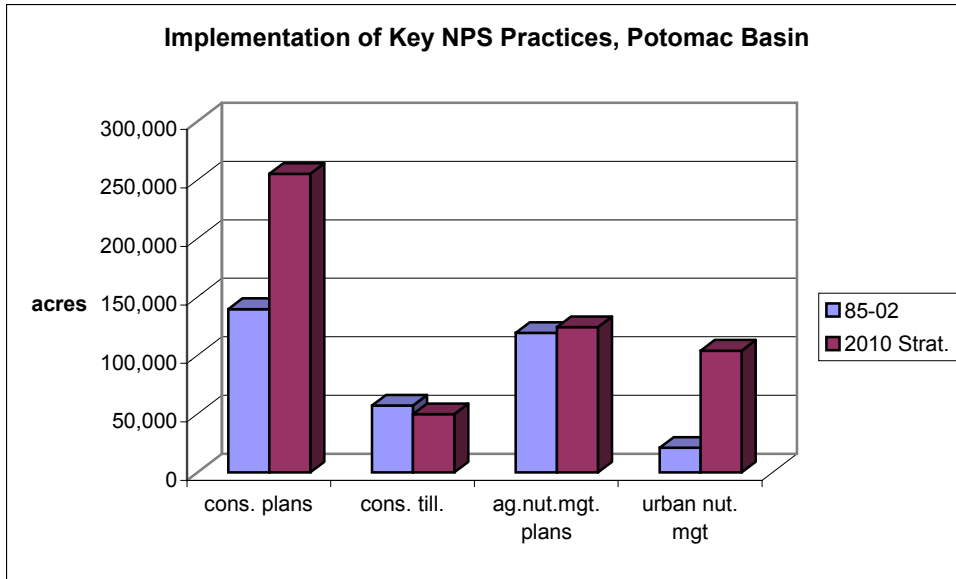
Grass Buffers (Hi)	acres	21,831	15,911	37,742
Grass Buffers (Low)	acres	0	0	0
Horse Pasture Management (MO)	acres	4,312	0	4,312
Land Retirement (Hay)	acres	0	0	0
Land Retirement (Hi)	acres	0	0	0
Nutrient Management Plans (Hay)	acres	76,895	148,583	225,478
Nutrient Management Plans (Hi)	acres	0	2,116	2,116
Nutrient Management Plans (Low)	acres	47,152	70,535	117,687
Off-Stream Watering w/ Fencing & RG (Pasture)	acres	26,692	27,648	54,340
Off-Stream Watering w/ Fencing (Pasture)	acres	39,895	55,298	95,193
Off-Stream Watering w/o Fencing (Pasture)	acres	13,299	55,298	68,597
Tree Planting (Hay)	acres	5,396	9,479	14,875
Tree Planting (Hi)	acres	0	0	0
Tree Planting (Pasture)	acres	8,311	16,264	24,575
Wetland Restoration (Hay)	acres	5,396	9,479	14,875
Wetland Restoration (Hi)	acres	0	5,303	5,303
Wetland Restoration (Low)	acres	0	0	0
Yield Reserve (Hay)	acres	4,047	3,128	7,175
Yield Reserve (Hi)	acres	2,459	1,485	3,944
Yield Reserve (Low)	acres	2,201	0	2,201
Non-Agricultural BMPs				
Dry Detention Ponds & Hydrodynamic Structures (IU)	acres	0	0	0
Dry Detention Ponds & Hydrodynamic Structures (PU)	acres	0	0	0
Dry Extended Detention Ponds (IU)	acres	0	0	0
Dry Extended Detention Ponds (PU)	acres	0	0	0
Erosion & Sediment Control (IU)	acres	7,796	5,623	13,419
Erosion & Sediment Control (PU)	acres	16,413	17,120	33,533
Filtering Practices (IU)	acres	22,972	4,017	26,989
Filtering Practices (PU)	acres	48,182	13,975	62,157
Forest Buffers (MO)	acres	26,896	11,383	38,279
Forest Buffers (PU)	acres	23,363	7,336	30,699
Forest Conservation (PU)	acres	0	0	0
Forest Harvesting Practices	acres	680	585	1,265
Grass Buffers (PU)	acres	0	0	0
Impervious Surface Removal	acres	0	0	0
Infiltration Practices (IU)	acres	22,972	4,017	26,989
Infiltration Practices (PU)	acres	48,182	13,975	62,157
Mixed Open Nutrient Management (MO)	acres	83,044	118,952	201,996
Septic Connections	connections	7,835	89	7,924
Septic Denitrification	systems	6,853	5,271	12,124
Septic Pumping	systems	51,397	39,533	90,930

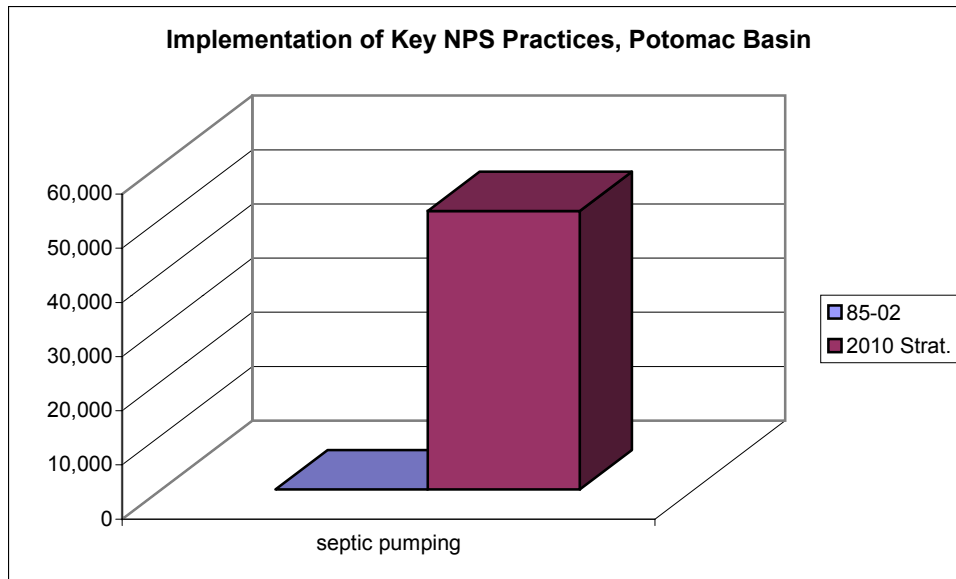
Tree Planting (MO)	acres	13,449	7,589	21,038
Tree Planting (PU)	acres	15,576	4,892	20,468
Urban Nutrient Management (PU)	acres	103,997	81,316	185,313
Urban Stream Restoration (IU feet)	acres	0	0	0
Urban Stream Restoration (PU feet)	acres	0	0	0
Wetland Restoration (MO)	acres	6,725	7,589	14,314
Wet Ponds & Wetlands (IU)	acres	22,972	4,017	26,989
Wet Ponds & Wetlands (PU)	acres	48,182	13,975	62,157

The following bar charts compare implementation rates from the seventeen year 1985 to 2002 time period with those the strategy calls for during the seven years through 2010 for several key nonpoint source best management practices in the York River basin. Implementation rates for all of these practices, and many others, will need to increase dramatically. Practices that are already heavily used will still need to be increased. In some cases the strategy calls for practices that have previously seen little or no implementation in the basin. While the strategy looked at the whole suite of BMPs available, there are a few practices in each basin that are not being used. In these cases either land use or some other condition did not make that particular BMP applicable to that basin. However every effort was made to identify and maximize the use of all applicable practices.









Shenandoah and Potomac Urban Input Deck highlights

This strategy assumes urban nutrient management principles greatly expanded to **200,000** acres in the Shenandoah and **187,000** acres in the Potomac of both pervious urban and mixed open land uses. Urban nutrient management involves the reduction of fertilizer to turf grass areas including home lawns, businesses, and public lands such as municipal parks, playing fields, schools, and right of ways. This would be accomplished largely through Department of Conservation and Recreation nutrient management staff and possibly local Virginia Cooperative Extension staff.

Low impact development practices such as swales and bio-retention areas (rain gardens) that capture and temporarily store water quality volume and pass it through a filter function as excellent pollutant treatment and recharge. Additionally, practices that promote infiltration of storm water run off are also beneficial. This strategy seeks to implement these innovative practices on **36,000** acres in the Shenandoah and **71,000** acres in the Potomac.

Erosion and sediment control is a required practice that seeks to protect water resources from pollution and runoff increase associated with land development activities. Examples of practices include silt fences, slope drains, and permanent vegetation. This strategy assumes that **23,000** acres in the Shenandoah and **24,000** acres in the Potomac will be developed with erosion and sediment controls

Greater enforcement of existing 5-year “septic tank pump out” requirement for localities subject to the requirements of The Chesapeake Bay Act helps achieve nutrient reductions. This Strategy considers that **39,500** on-site systems in the Shenandoah and **51,000** on-site systems in the Potomac will be pumped out by 2010.

Septic de-nitrification represents the replacement of traditional septic systems with more advanced systems that have expanded nitrogen removal capabilities. Although not currently

utilized to any great extent in either basin, this Strategy proposes some **5,000** future systems in the Shenandoah and **6,800** future systems in the Potomac to be installed by 2010.

Potomac Agriculture Input Deck highlights

Nutrient management plan implementation is a comprehensive plan that describes the optimum use of nutrients to minimize nutrient loss while maintaining yield. Plans are generally revised every 2-3 years. This strategy proposes to bring **220,00** new hay and low-till acres in the Shenandoah and **124,000** similar acres in the Potomac under such plans by 2010.

Stream protection both with and without fencing requires the use of alternative drinking water troughs away from streams. The effectiveness of this practice reflects at least the partial removal of livestock from stream areas and relocation of animal waste and traffic areas to more upland locations. This strategy proposes **138,00** acres in the Shenandoah and **80,000** acres in the Potomac of this best management practice.

Riparian grass and forest buffers are linear strips of grass or wooded area along rivers, stream, and shorelines. They are very effective at filtering nutrients, sediments and other pollutants from runoff. This strategy proposes **73,000** acres protected by buffers in the Shenandoah and **76,000** acres protected by buffers in the Potomac.

Conservation tillage involves planting and growing crops with minimal disturbance of surface soil. No-till and minimum tillage farming is a form of conservation tillage. This strategy greatly expands conservation tillage to **70,000** acres in the Shenandoah and **50,000** acres in the Potomac.

Cover crops reduce erosion and the leaching of nutrients by maintaining a vegetative cover on cropland and holding nutrients within the root zone. The crop is seeded directly into vegetative cover or crop residue with little disturbance of the surface soil. This Strategy expands this beneficial practice by **69,000** acres in the Shenandoah and **50,000** acres in the Potomac.

Building on accomplishments

The initial *Shenandoah and Potomac River Basins Tributary Nutrient Reduction Strategy* released in December 1996, committed to reducing nitrogen and phosphorus entering the Bay by 40 percent by the year 2000. Stakeholders, working through a public process, relied heavily on agricultural controls and wastewater treatment plant upgrades to achieve an “across the board” 40 percent reduction in nitrogen and phosphorus from each basin locality. The major non-point source components included agricultural BMPs and agricultural nutrient management planning. The agricultural BMPs have been implemented through Virginia’s Agricultural Best Management Practices Cost Share Program, which is administered locally by soil and water conservation districts (SWCDs). Nutrient management planning has been accomplished through the combined efforts of DCR nutrient management staff, local SWCD staff, and through private certified nutrient management planners.

Implementation of the 1996 Shenandoah and Potomac Tributary Strategy provided important lessons for the basin’s continued efforts to reduce and cap nutrients and sediment. Many of these lessons, which were initially described in the March 2001 *Draft Interim Nutrient Cap Strategy*

for the Shenandoah and Potomac River Basins, continue to present significant challenges today, and are summarized below:

- Stakeholders will do their share towards water quality restoration when financial incentives are provided.
- Continued commitment to the tributary strategies by the Commonwealth through financial and program support is critical for success.
- Adequate technical staff must be provided to market and support the installation of agricultural conservation practices.
- The program and technical components of the strategies must be flexible enough to reflect new and changing opportunities for nutrient and sediment reductions.
- Strategy components must be linked to local water quality concerns to obtain and maintain local stakeholder involvement.
- Maintaining nutrient and sediment reductions as population increases must be addressed.
- Sustained effort is needed to refine and update significant best management practices and their corresponding removal rates and cost efficiencies so that resources can be targeted in the most effective manner and meaningful comparisons can be made between point and non-point source option.

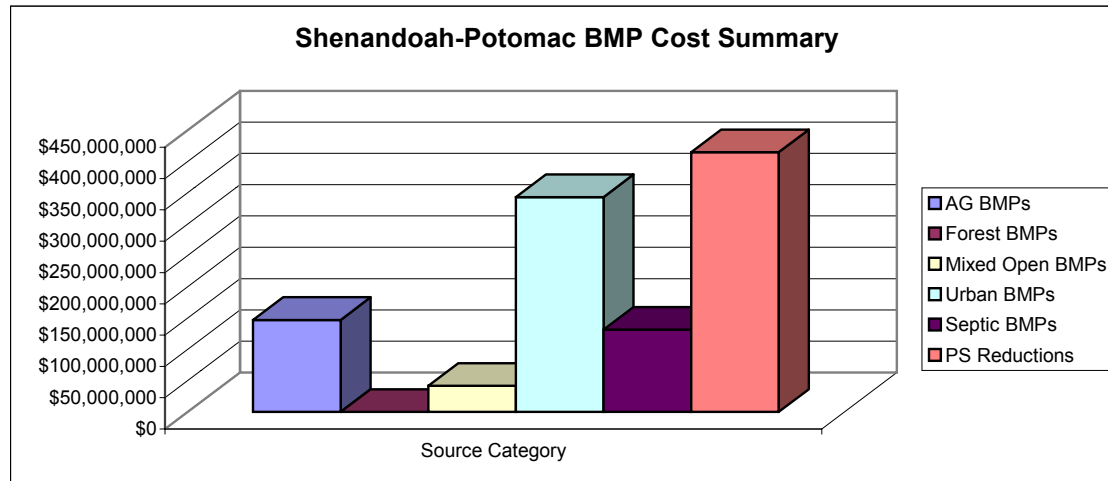
In addition to these lessons, the 2001 Interim Cap Strategy noted that achieving additional reductions and maintaining those reductions would require the Commonwealth to shift the emphasis for reductions to areas other than agriculture. Managing stormwater runoff and implementing nutrient management on the Commonwealth's expanding urban lands were identified as priority targets in the 2001 document, and continue to provide a focal point for achieving and maintaining nutrient and sediment reductions. Although useful in its analysis, the document was never finalized due to the impending need for an updated Tributary Strategy in 2004.

Cost information

The total costs to implement the tributary strategies for the Virginia portion of the Chesapeake Bay is \$3.2 billion. The estimated cost for the Shenandoah-Potomac strategy is \$1.17 billion with \$357 million in the Shenandoah and \$820 million in the Potomac basin. These estimates include point sources, nonpoint sources and technical assistance costs to implement the nonpoint source reductions required.

Cost estimates are provided for both nonpoint and point sources for each of the tributary strategy basins. Costs for the Shenandoah-Potomac strategy are broken down according to source category in the bar chart below. Detailed summary sheets for both the Shenandoah and Potomac are provided in Appendix E, showing the number of BMPs and amount of point source reductions for each basin. The technical assistance costs included in the estimates above do not appear in the Appendix E charts.

Cost Estimates by Source Category



Nonpoint Source Costs

The nonpoint source costs are based on structural costs to implement BMPs for the source categories: agriculture, urban, mixed open, septic and forest. The cost estimates considered structural costs to implement BMPs, costs for services to implement BMPs such as nutrient management planning, septic pumping, etc., and materials and equipment usage costs to implement BMPs such as the agronomic practices for agriculture (i.e., cover crops, and conservation tillage). Technical assistance costs were also calculated and added to the BMP cost to obtain the total implementation costs. (See Tables 7-8) Maintenance costs were not included in the estimates.

The sources of information used to develop the cost estimates were as follows:

- Chesapeake Bay Program, Use Attainability Group Report, “Economic Analyses of Nutrients and Sediment Reduction Actions to Restore Chesapeake Bay Water Quality” (primary reference source). Urban BMP costs were taken from this source along with a small number of agricultural practices.
- Virginia’s Agricultural Cost-Share Program Tracking Database, period of record was 1998-2002. Stream fencing practices were adjusted based on 2002 data.
- DCR’s staff was consulted for nutrient management costs, erosion and sediment control costs, and the cost to transfer poultry litter.
- Study by Virginia Polytechnic Institute and State University and the United States Department of Agriculture was used for the forest harvesting practices.

The cost for the septic BMPs – connection to public sewer and septic tank pumping were based on information from nonpoint source implementation projects funded by DCR. Costs for the installation of a septic denitrification system was based on the assumption that most of the systems accounted for in the tributary strategy would be for new construction as compared to replacement of failing conventional on-site sewage disposal systems. The average cost figure for a denitrification system is \$12,565 and the average cost for a conventional system is \$4,500. The difference of \$8,065 was used to calculate the cost for the advanced treatment to obtain the additional nitrogen removal per system.

Point source costs

The point source capital costs are planning level, order-of-magnitude figures (accurate from -30% to +50%), based on a combination of owner-furnished data and results from an estimation methodology developed by the Chesapeake Bay Program's Nutrient Reduction Technology (NRT) Workgroup. This Workgroup included state and federal staff, several treatment plant owners, academia, and two experienced and respected consulting engineering firms. More accurate figures can only be determined through specific facility planning, design, and ultimately construction bids for the necessary treatment upgrades.

The NRT methodology included assumptions about treatment types, plant sizes, and needed unit processes, to reduce nitrogen and phosphorus in order to meet three annual average discharge performance "tiers":

- Biological Nutrient Removal (BNR): TN = 8.0 mg/l; TP = 1.0 mg/l
- Enhanced Nutrient Removal (ENR): TN = 5.0 mg/l; TP = 0.5 mg/l
- Limit-of-Treatment (LOT): TN = 3.0 mg/l; TP = 0.1 mg/l

It is recognized that if a particular treatment level is chosen to meet a basin load allocation in the year 2010, it is probable that more stringent treatment will be needed to maintain the reduced load into the future. This is the case where a plant has not yet reached its design capacity in the year 2010, but must "cap" its discharge load as flows increase.

The point source cost estimates were developed using the "tier" that most closely matched the proposed level of treatment in each tributary strategy planning area. As a result, it is possible that the cost figures are under-estimated. This is due to the fact that some plant owners could chose to install a more stringent treatment process now, to maintain a "cap" load at the design capacity, rather than meeting an interim 2010 load goal and potentially face multiple construction projects to retrofit their plant. The most conservative cost estimate (i.e., highest cost, associated with limit-of-treatment technology) was used only for the municipal plants in the northern Virginia portion of the Potomac basin (excepting Upper Occoquan Sewage Authority), and municipal dischargers to the tidal-fresh portion of the Middle James basin (excepting Hopewell).

Table 6 6-Year Timeline, Annual Implementation Levels and Technical Assistance for Nonpoint Sources.

Date (year)	Agriculture (%)	Urban (%)	Mixed Open (%)	Septic (%)	Forest (%)	Ag. TA (%)	Urban, MO TA (%)	Septic, Forest TA (%)
1	10	15	10	15	15	10	20	5
2	15	15	15	15	15	10	20	5
3	15	15	15	15	15	10	20	5
4	20	15	20	15	15	10	20	5
5	20	20	20	20	20	10	20	5
6	20	20	20	20	20	10	20	5

Provided in the table above is a level of implementation based on a projected percentage of the total BMPs by source category that would have to be implemented yearly to achieve the tributary strategies by 2010. These percentages were used to project the structural costs on an annual basis for each of the nonpoint source categories to implement the tributary strategies. Also, included in the table is factors (expressed as a percentage) used to estimate the technical assistance costs to implement the tributary strategies. The agricultural technical assistance costs was based on 10 percent of the structural cost, the urban and mixed open (MO) technical costs were based on 20 percent of the structural costs, and septic and forestry technical costs were based on five percent of the structural cost.

The technical assistance costs are based on a uniform percentage over the six-year implementation period. The percentages of yearly implementation of BMPs were adjusted to account for the expectation that the implementation levels in the earlier years will not be as great as compared to the later years due to an initial time lag. This is anticipated as a result of putting into place more technical assistance, making programmatic and regulatory changes, improving implementation reporting and tracking efforts, and obtaining substantial amounts of funding.

Table 7. Nonpoint Source Costs – Potomac

Potomac River Basin							
	Imp Yr 1	Imp Yr 2	Imp Yr 3	Imp Yr 4	Imp Yr 5	Imp Yr 6	Totals
Agriculture BMPs	6.656	9.984	9.984	13.313	13.313	13.313	66.563
Urban BMPs	35.995	35.995	35.995	35.995	47.993	47.993	239.966
Mixed Open BMPs	2.657	2.657	2.657	5.315	5.315	5.315	26.574
Septic BMPs	12.165	12.165	12.165	12.165	16.220	16.220	81.102
Forest BMPs	0.002	0.002	0.002	0.002	0.003	0.003	0.016
Agriculture TA \$	0.666	0.998	0.998	1.331	1.331	1.331	6.656
Urban & Mixed Open TA \$	7.730	7.730	7.730	8.262	10.662	10.662	53.308
Septic & Forest TA \$	0.608	0.608	0.608	0.608	0.811	0.811	4.056
Total Basin Estimated NPS Cost including Technical Assistance							478.241

* Cost in Millions of Dollars

Table 8. Nonpoint Source Costs – Shenandoah

Shenandoah River Basin							
	Imp Yr 1	Imp Yr 2	Imp Yr 3	Imp Yr 4	Imp Yr 5	Imp Yr 6	Totals
Agriculture BMPs	8.052	12.078	12.078	16.104	16.104	16.104	80.522
Urban BMPs	15.548	15.548	15.548	15.548	20.731	20.731	103.656
Mixed Open BMPs	1.525	2.287	2.287	3.049	3.049	3.049	15.246
Septic BMPs	7.583	7.583	7.583	7.583	10.110	10.110	50.551
Forest BMPs	0.002	0.002	0.002	0.002	0.002	0.002	0.012
Agriculture TA \$	0.805	1.208	1.208	1.610	1.610	1.610	8.052
Urban & Mixed Open TA \$	3.415	3.567	3.567	3.719	4.756	4.756	23.781
Septic & Forest TA \$	0.379	0.379	0.379	0.379	0.506	0.506	2.528
Total Basin Estimated NPS Cost including Technical Assistance							284.348

* Cost in Millions of Dollars

IV. Implementing the Strategies:

A Message from the Secretary of Natural Resources

This strategy and similar strategies prepared for Virginia's Chesapeake Bay tributaries propose a suite of nonpoint source best management practices, sewage treatment plant upgrades and other actions necessary to achieve the specified nutrient and sediment reductions. The analysis and practices contained in this strategy are an important first step and bring together state and regional goals informed by an understanding of local conditions as developed by the tributary teams. However, as the input decks outlined in the previous section of this document make clear, achieving the necessary implementation levels go far beyond what we have previously seen. In order for these strategies to be meaningful, we must identify what additional resources and tools are necessary to achieve and cap these nutrient reductions in the timeframe called for by the Chesapeake 2000 Agreement. We must also further refine these strategies with specific information regarding implementation budgets and timetables.

The citizens of Virginia should receive this clear message. Restoration of the Chesapeake Bay is possible but it will not come without substantial public and private resources and programs that ensure that management practices are adopted and maintained. Without such actions, the promises we have made have no meaning. Without such actions, the economic and environmental benefits of a restored bay will not be realized.

The tributary teams have raised a variety of issues regarding implementation, tracking and cost and those questions need to be addressed as we move forward. The purpose of this chapter is to build on those issues and outline in broad terms the implementation approach for these strategies. During the public comment period and beyond, the public is invited to offer comments and provide guidance on the issues and questions that follow.

Funding

Part Three of this strategy outlines the magnitude of funding necessary to address the various sources of nutrient and sediments. It is clear that implementation of these strategies will require financial resources that are far beyond those currently available. Governor Warner has proposed a dedicated source of funds for water quality improvement and land conservation, however the current stalemate in the state budget process has put the Governor's proposal as well as funds proposed by the Senate in doubt.

There is also activity at the regional level. The Chesapeake Executive Council has appointed a high level panel to address funding issues. Chaired by former Virginia Governor Gerald Baliles, the panel has begun its deliberations is expected to release its findings and recommendations in October 2004.

As part of its review of this and the other strategies, the public is invited to address the funding issue with suggestions on how additional funding can be obtained to implement this strategy. In the meantime, efforts to target existing resources will be pursued. These strategies provide the basis for evaluating the areas with greatest need.

Point source implementation

Implementation of point source reductions will be accomplished through completion of sewage treatment plant upgrades currently underway as well as final adoption of regulatory programs that are currently being developed by the Department of Environmental Quality.

Regulatory Programs Now Under Development

As described previously in this document, the EPA Chesapeake Bay Program Office published water quality criteria related to dissolved oxygen, water clarity and chlorophyll “a” that will serve as the basis for the revision of water quality standards for the states in the Chesapeake Bay watershed with tidal waters (Maryland and Virginia). The criteria, when achieved, will provide the habitat necessary to protect the bay's fish, shellfish, crabs and other living resources. A notice of intended regulatory action (NOIRA), the first step in the regulatory process to amend water quality standards, was published in the Virginia Register on November 17, 2003. The regulatory process prescribed by the Virginia Administrative Process Act is now underway. The public comment process on the proposed revisions to the standards should take place later this year.

In December 2003, Governor Warner announced the beginning of a regulatory process to establish a range of technology-based nutrient limits in discharge permits within the Chesapeake Bay watershed. The regulation will complement the water quality standards regulation and ensure that the nutrient reductions will occur. A NOIRA for this rulemaking has been published in the Virginia register and the regulatory process has begun.

These concurrent rulemakings will ensure that Virginia has the regulatory tools that define the water quality goals we are committed to achieving for the Chesapeake Bay and its tidal rivers and will serve as the basis for implementation of these strategies.

Accommodating Future Growth

The pollutant loads assigned to point and non point sources must be capped over time. The capacity of existing sewage treatment plants to handle future growth in their communities needs to be assured while at the same time not exceeding the load allocation caps for those particular plants or for an entire river basin. In addition, even if the point source regulation requires that all new plants must achieve limit of technology (LOT) treatment, there is a new load associated with even a LOT facility. Therefore, how can new or expanded treatment plants be accommodated?

Nonpoint source implementation

Nonpoint sources account for the majority of nutrients flowing into the Chesapeake Bay system and at the same time, because of their diffuse nature, they are the most difficult to control. There has been some success in addressing nonpoint sources, but the kind of comprehensive implementation necessary to improve water quality remains elusive. While existing programs, including cost-share programs on agricultural land and the Commonwealth's newly reorganized and expanded stormwater management law, will be brought to bear on nutrient and sediment pollution, better use of existing authorities and an examination of what mix of regulatory and voluntary programs are necessary must begin.

Comprehensive Management of Nutrients and Sediments on Land

The strategies rely heavily on adoption and implementation of nutrient management plans on both agricultural and urban lands. How can consistent and comprehensive application of nutrient management plans on both agricultural and urban lands be achieved?

Are there improvements that can be made to current agriculture nonpoint source control programs to better address nutrient issues? For example, nutrient management plans are currently required by poultry operations that use waste on their own lands. However, nutrient management plans are not required for those who use waste generated on other farms. How should this discrepancy be addressed?

Septic systems are currently an uncontrolled source of nitrogen. Should all newly installed septic systems and replacement systems be required incorporate processes to remove nitrogen from effluent?

Beneficial uses of animal and poultry waste must be more aggressively pursued. Value added products produced from animal or poultry waste or “waste to energy” facilities can help address nutrient issues. How can these approaches be broadly implemented in Virginia?

Buffers along streams and rivers have proven to be an effective practice to reduce nutrients and sediments. In addition to programs such as the Conservation Reserve Enhancement Program that establish buffers on agricultural lands, programs such as the Chesapeake Bay Preservation Act require buffers along perennial streams in Eastern Virginia. What can be done to accelerate the establishment of buffers along Virginia’s streams and rivers?

The placement of sewage sludge (sometimes called “bio-solids”) on agricultural lands is increasing. Are programs currently in place sufficient to address the impacts of this source of nutrients?

Land use

As these strategies recognize, the landscape is changing. Growth and development will alter the ratio of sources and conversions from less intensive land uses to more intensive uses will continue. These strategies recognize that new methods of land management, particularly low impact development practices, will need to be employed on a much larger scale. This approach must be pursued concurrently with improved enforcement of erosion and sediment control and other traditional land management practices.

How can these new land management practices become integral parts of local land use and land management programs particularly in areas outside those governed by the Chesapeake Bay Preservation Act?

Next steps

Although considerable efforts have gone into the development of this strategy, it is not complete. While we have identified the point and nonpoint source practices necessary to achieve our goals, a good deal of work with regard to the implementation of these practices remains to be done. Following the public comment period, these strategies will be supplemented with additional detail regarding implementation responsibilities, budgets and timetables. We must clearly show how each of the practices proposed can be implemented; first, by showing what existing programs can accomplish with known resources and second by showing what additional resources will be necessary to complete implementation. In addition, detailed progress reports will be made annually to the Governor, the General Assembly and the citizens of Virginia as part of the required annual report on Tributary Strategy implementation.

As the implementation of the strategies proceed, tributary teams and state agencies will assume the following responsibilities.

- Establish process to evaluate progress and success
- Establish specific timeline to achieve pollutant load allocations by 2010
- Guide and prioritize implementation activities
- Refine Input Deck as revised data become available
- Develop outreach initiatives and strategies
- Collaborate with watershed organizations to promote and guide implementation
- Help localities, Soil and Water Conservation Districts, Planning District Commissions and businesses with local and regional watershed planning

State agencies and the tributary teams will also work closely with Planning District Commissions and Soil and Water Conservation Districts and other partners in order to:

- Encourage local governments to adopt and maintain tracking systems to account for the establishment of urban best management practices
- Promote specific strategy components to localities
- Assist in the development and implementation of local watershed plans that support the strategy
- Encourage landowners to implement specific BMPs
- Provide to local governments the technical assistance and analysis of environmental data to support program development and implementation
- Provide technical GIS capability to support local programs
- Promote, coordinate and track agricultural and urban BMPs
- Facilitate consensus among localities in each PDC jurisdiction on strategy development, refinement and implementation

An interagency steering committee operating under the direction of the Secretary of Natural Resources coordinates state oversight of the tributary strategy process. The committee will:

- Re-evaluate strategies, as necessary following the adoption of new water quality standards and based on the scheduled 2007 re-evaluation by the Chesapeake Bay Program.
- Maintain clear lines of communication in state government
- Report on implementation through an annual report
- Better engage federal agency partners
- Prioritize Chesapeake 2000 Agreement commitments that facilitate or support tributary strategy implementation
- Identify data and map support needs
- Maintain and enhance state nonpoint source assessment and targeting information
- Target available funding resources
- Promote “government-by-example” activities, such as low impact design for state projects
- Provide ongoing support for local watershed planning activities
- Refine implementation timelines
- Ensure committee composition that includes needed expertise and comprehensive agency input

The challenge is now to turn these plans into reality and to continually refine them so they implement the most effective and efficient methods to achieve our ambitious goals.

Appendices

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Appendix A – Shenandoah Tributary Strategy Team Information

Consideration and acknowledgement is due to the members of the Virginia Shenandoah Tributary Team Members who assisted in the production of the Shenandoah Strategy:

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Rick Chandler	Town of Dayton
Tom Christoffel	Northern Shenandoah Valley Regional Commission
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Tim Crider	Town of Grottoes
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 Chesapeake Bay Foundation
 Merck
 VA Department of Transportation
 City of Front Royal
 Headwaters SWCD
 Virginia Dept. of Conservation and Recreation
 VA Department of Environmental Quality
 Dupont (Invista)
 Merck
 Shenandoah County
 Frederick County
 Lord Fairfax SWCD
 Natural Resources Conservation Service
 Rockingham County Farm Bureau
 Shenandoah Pure Water Forum
 Toms Brook

 Town of Woodstock
 City of Waynesboro
 VA Department of Conservation and Recreation
 Frederick-Winchester Service Authority
 Town of Mt. Jackson
 Lord Fairfax SWCD
 Page County Water Quality Advisory Committee
 Town of Bridgewater
 Town of Broadway
 Coors
 Friends of the North Fork
 Headwaters SWCD
 Harrisonburg-Rockingham Regional Sanitation Authority
 Canaan Valley Institute
 Town of Berryville
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 Coors
 Town of New Market

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 ICPRB
 City of Winchester
 Town of New Market
 Lord Fairfax SWCD
 Town of Luray

 City of Harrisonburg
 Warren County
 Potomac Conservancy
 Shenandoah County Water Resources
 Canaan Valley Institute

 VA Department of Transportation
 City of Harrisonburg
 Rockingham County

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Tim Youmans
YB Yount

Natural Resources Conservation Service

Augusta County
Georges Chicken
Frederick County
City of Winchester
City of Waynesboro

Shenandoah Tributary Team Considerations

The initial attempt to develop a mix of BMPs that would result in reductions to meet the allocation was carried out at the Team level. The Team strategy identifies what measures could be implemented in the Shenandoah watershed to meet the reduction goals, assuming that abundant resources would be made available. The Team members representing the Commonwealth developed the initial strategy for the urban source category with guidance from the Urban Working Group. The level of effort is a calculated average of the Chesapeake Bay Program Tier 3 and Tier 4, as applied to the Chesapeake Bay Program's projection of urban land uses in 2010.

In keeping with the necessary emphasis on reductions on urban land, the initial strategy for the Shenandoah proposed that urban nutrient management be applied to all urban land by the year 2020. Urban nutrient management involves the reduction of fertilizer to turf grass areas including home lawns, business, and public lands, such as parks, playing fields, school campuses, and rights of ways.

In addition, the initial strategy proposed that stormwater management practices be applied to sixty percent of all urban land by the year 2020. Stormwater management involves the installation of ponds, infiltration swales, and rain gardens (bioretention areas) to capture and temporarily store runoff from developed areas to filter out nutrients, sediment, and other pollutants. Other practices proposed for reducing nutrients and sediment from urban land include the creation of forested and grass buffers along streams, the installation of erosion and sediment control practices on newly developed land, and regular septic system pumpouts. Additional opportunities for nutrient reductions exist through the connection of septic systems to wastewater treatment facilities, and the installation of septic denitrification systems.

While the strategy does place a significant new focus on urban land, continued efforts on agricultural land promises to yield substantial nutrient and sediment reductions as well, especially in light of the Shenandoah watershed's significant agricultural land base. The Agricultural/Forestry Working Group utilized past implementation trends and forecasted potential future implementation as applied to local land use knowledge and the CBPO projection of agriculture and forestry land uses in 2010.

The initial strategy placed emphasis on the installation of animal waste management systems and the implementation of nutrient and farm plans for both nutrient and sediment reduction. Animal waste management systems provide facilities for the storage and handling of livestock and poultry waste and the control of surface runoff water. The proposed strategy places an additional emphasis on liquid systems, such as dairies. Nutrient management plan implementation provides optimum use of nutrients to maintain yield while minimizing nutrient loss. Farm plan

implementation focuses on the reduction of sediment loss from cropland. Other practices proposed for reducing nutrients and sediments from agricultural and forest land include conservation tillage, retirement of highly erodible land, the creation of forest and grass buffers along streams, the exclusion of livestock from streams, rotational grazing, and the use of cover crops.

Some of the members of the group expressed concern over the calculated levels of implementation for forested and grass buffers, and indicated that conflict between best management practice requirements and local high grass ordinances may pose problems for implementation. It was recommended that funds be made available through grant assistance for on-site pumpouts and connection of on-site systems to public sewers, and these methods be given serious consideration as components in the strategy. A specific recommendation was offered that maintenance contracts be required for on-site denitrification systems through the mortgage process, because these types of BMPs are maintenance-dependent.

Some members of the group recommended that state government must initiate specific components of the strategy. This would lessen the challenges faced by localities when attempting to make major policy changes. Specifically, it was recommended that the Commonwealth initiate statewide nutrient management planning through public education and a ban on the sale of fertilizer to the everyday consumer. Instead, it was recommended that the Commonwealth create a program that would allow citizens to apply fertilizer to their property through a certification program. A recommendation was also offered regarding the installation of on-site denitrification systems through a state-level initiative.

Also, the Urban Working Group did recognize the link between land use and water quality, and some members requested that consideration be given to how specific components of the strategy may affect local growth management strategies. (See Appendix for submitted concerns and recommendations from members of the Urban Working Group).

Stakeholders voiced additional recommendations throughout the process consistently. Several members offered specific technical advice and guidance, such as the recommendation incorporate soil management techniques to stimulate and increase soil microbial activity to reduce nutrient leaching while providing for crop needs. The concept of the conservation of mass and the lifecycle of nutrients was raised, and the recommendation was offered that nutrients, whether in the form of litter and manure or taken up in a plant, must be removed from the watershed to achieve lasting reductions in nutrients in the Chesapeake Bay.

Throughout this continuous process of developing proposed methods of achieving nutrient and sediment reductions, stakeholders are encouraged to raise substantive concerns and recommendations. The comments range from policy-level issues such as the level of effort that should be reasonably expected from a particular source category, to implementation-level issues such as how the installation of best management practices is tracked. While consensus has not been reached on many issues, the process is successfully allowing the open communication of knowledge, ideas, and problems. Summarized below are the specific points raised by stakeholders involved in the Shenandoah Tributary Strategy development process.

The Point Source Working Group recommended that non-point source best management practices, especially the creation of riparian buffers, are more cost-effective (per pound of nutrient removed per dollar) than installing advanced chemical and biological nutrient removal technologies at significant point sources. This group also indicated that streams with impaired water quality due to fecal coliform or benthic issues often require the same or similar best management practices as those used for reducing nutrients. The group draws the conclusion that by implementing non-point source BMPs, multiple water quality objectives may be reached.

Regarding this topic, the Agriculture/Forestry Workgroup indicated that limited physical opportunities exist for the creation of riparian buffers throughout the watershed. This would in turn limit the extent to which that particular BMPs could be proposed. Also, the group believed that by relying on individual landowners to pay a portion of the cost of the installation of agricultural BMPs, a greater cost is imposed on the families of the nonpoint source category, in contrast to the opportunity for a point source facility to pass the cost of nutrient removal to the many users of the facility.

There was a point raised by some stakeholders that point source facilities discharging less than 0.5 million gallons per day are not considered “significant discharges” and nutrient reductions are not specifically proposed for them. Some stakeholders contended that no one subgroup, even if their source load contribution is small, should be singled out as exempt from the challenge of improving water quality. The point was raised by several stakeholders that the “non-significant” discharges may create substantial local water quality problems as the a major contributor in a small subwatershed, even if that facility were less than significant in the overall Shenandoah-Potomac watershed.

Regarding this topic, the Point Source Working Group reported that the “significant dischargers” account for 16 percent and treat 83 percent of the total nitrogen load for the Shenandoah watershed. The group did not believe it would be cost effective to require advanced nutrient removal technologies at the “non-significant dischargers” since they represent only a fraction of the total nitrogen load. The group did support the proposal for operator training at these non-significant dischargers for operational changes to increase nutrient removal. Also, the group supported a proposal that point sources greater than 0.30 million gallons per day sample and test effluent quarterly for total nitrogen concentrations and semi-annually for total phosphorus concentrations, while those less than 0.30 million gallons per day test semi-annually and annually for total nitrogen and total phosphorus, respectively. The Point Source Working Group did recognize that most dischargers will receive some sort of nutrient limits in the future, and supported the concept of nutrient control goals for all point source dischargers.

The Point Source Working Group also made several specific recommendations regarding the establishment of nutrient limits, requesting that the method of determining compliance with nutrient loads allow room for periodic effluent quality variation, provided compliance with annual average total nitrogen and total phosphorus loads is maintained. The group also expressed concern over the potential of nutrient limits appearing in discharge permits within the next two years and requested that the implementation schedules be allowed to extend beyond the five-year terms of the discharge permit that would initiate the limits. This extension is based on the assumption that state and federal monies would be available to assist with upgrades, and would

allow for grant acquisition and other financing, public procurement of engineering services, and project completion.

Appendix B – Potomac Tributary Strategy Team Information

Consideration and acknowledgement is due to the members of the Virginia Potomac Tributary Team Members who assisted in the production of the Potomac Strategy, special thanks especially to the individuals who provided leadership to the three subcommittees:

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John Bell	Tri-County/City SWCD
Stephen Bennett	Prince William County Service Authority
Matt Berres	Potomac Conservancy
Alex Blackburn	Loudoun County Soil Scientist
Stacey Blersch	US Army Corps of Engineers
Kevin Blythe	VA Department of Forestry
Jim Boland	Loudoun SWCD
Tom Broderick	Loudoun County Sanitation Authority
Will Bullard	US Department of Defense - Navy
Anne Burgess	Prince William County Citizen
Ron Burgess	Prince William County Citizen
Bob Canham	Prince William County Service Authority
Keshia Cheeks	VA Department of Conservation and Recreation
Deirdre Clark	Fauquier County Building and Development
Jeff Corbin	Chesapeake Bay Foundation – Richmond Office
Debbie Cross (<i>Agriculture co-Lead</i>)	VA Department of Conservation and Recreation
Keith Dickinson	Virginia Cooperative Extension – Fauquier
Roger Diedrich	Sierra Club – Fairfax Chapter
Thomas Faha	VA Department of Environmental Quality
Adrian Fremont	City of Fairfax Public Works and Engineering
Normand Goulet	Northern Virginia Regional Commission
Tom Grizzard	VA Tech-Occoquan Watershed Monitoring Lab
Barry Harris	USDA- Natural Resources Conservation Service
Art Hart	Tri City/County SWCD
Glenn Harvey (<i>Point Source Lead</i>)	Alexandria Sanitation Authority
Carlton Haywood	Interstate Commission Potomac River Basin
Shelby Hertzler	VA Department of Conservation and Recreation
Diane Hoffman	Northern Virginia SWCD
Kim Hosen	Prince William Conservation Alliance
Steven Hubble	Stafford County Planning and Development
Wade Hugh	Prince William County Public Works
Sam Johnson (<i>Agriculture co-Lead</i>)	Virginia Cooperative Extension - Westmoreland
Robert Jordan	Potomac River Greenways Coalition
Traci Kammer-Goldberg	Fairfax County Water Authority
Tamara Keeler	VA Department of Conservation and Recreation
John Kennedy	VA Department of Environmental Quality
Dipmani Kumar	Fairfax County Public Works
Patricia Kurpiel	Stafford County Citizen
Jim Lawrence	Lord Fairfax SWCD
Phillip A. Lewis	Dale City Service Corporation
Martha Lyons-Holland	Prince William County Citizen
Heather Mackey	Chesapeake Bay Local Assistance Department
Evelyn Mahieu	Upper Occoquan Sewage Authority
Mike McGrath	Fairfax County Water Authority
Terry Miller	Dale City Service Corporation
Jesse Moffett	Winchester Service Authority
Madan Mohan	Prince William County Public Works

Shahram Mohsenin	Fairfax County Public Works
Katherine Mull	Northern Virginia Regional Commission
Kate Norris	Prince William SWCD
Judy Okay	VA Department of Forestry
Jason Papacosma	Arlington County Environmental Services
Ryan Pacquet	Lake Jackson Homeowners Association
Greg Prelewicz	Fairfax County Water Authority
Mark Remsberg	King George County Planning and Zoning
Fred Rose	Fairfax County Public Works
Brian Rustia (<i>Non-point Lead</i>)	Metro Washington Council of Governments
Daniel Schwartz	Northern Virginia SWCD
Kelly Shenk	US EPA – Chesapeake Bay Program Office
Lyle Shertz	Lord Fairfax SWCD
Robert Shoemaker	VA Department of Conservation and Recreation
Angela Sowers	US Army of Corps Engineers
Gary Switzer	VA Department of Conservation and Recreation
Alison Thompson	VA Department of Environmental Quality
Tom Turner	John Marshall SWCD
David Ward	Loudoun County Stormwater Management
Chuck Weber	Prince William County Service Authority
Aileen Winquist	Arlington County Environmental Services

Potomac Tributary Team Considerations

The development of the Potomac Tributary Strategy has been an open and accessible process. Nine announced meetings were held throughout the basin as often as twice a month during the September 2003 through March 2004 timeframe. Meetings provided diverse participants with information on how the reduction allocations were made, laid out a framework for what needed to be accomplished, and solicited input on how to do it. Stakeholders were divided into three subcommittees: Point Source, Non-Point Source Urban, Non-Point Source Agriculture, with a lead person identified for each committee. Staff from the Department of Conservation and Recreation and the Department of Environmental Quality worked closely with stakeholders to explore and evaluate a wide variety of point and nonpoint source pollution control measures. Analysis provided by the CBPO that showed implementation levels at various levels or “tiers” of efforts was used as a starting point for discussion with stakeholders. It was noted repeatedly that The Potomac Team worked so well together that continuation as an “implementation team” is recommended.

The Potomac Team, working through the 3 sub-committees, presented an ambitious Tributary Strategy I (TSI) to the CBPO in February 2004 that represented for the most part a voluntary approach on the part of the localities and treatment plants to develop an equitable and “do-able” scenario to meet an ambitious allocation level. Unfortunately, TSI did not meet the reduction allocation by approximately 1.6 million pounds. Efforts were then undertaken by state natural resources staff to build on to this initial work to develop a strategy that met the basin’s allocations.

Both the Urban and Agricultural Subcommittees brought up important issues. For agriculture, concern was raised about past and present BMP tracking in terms of both BMP numbers and acres submitted from the local level versus what was credited by the CBPO. Also noted was that a large segment of the agricultural community is believed to be implementing best management

practices on a voluntary basis. If the practices are in accordance with standard specifications, then they should be recognized and accounted for through the state's tracking system. The recommendation for the agricultural cost share program to consider adding horses as eligible for cost share funding under Animal Waste Management as well as for Horse Pasture Management was also noted. For the urban community, a critical need for a simple, easy to use, urban best management practice tracking system at the state level to keep accurate records of both existing and new storm water management and other urban practices was repeatedly brought up.

The Point Source Subcommittee of the Potomac Tributary Team focused issues affecting wastewater treatment plants operating in the northern Virginia region. Facility representatives on this subcommittee expressed their opinions on the achievement and maintenance of point source nutrient load "caps", endorsing positions advocated by the Virginia Association of Municipal Wastewater Agencies (VAMWA). They cited three important local conditions that need to be considered in the Potomac Tributary Strategy:

Blue Plains is a major facility (370 MGD design capacity) owned and operated by the DC Water and Sewer Authority (WASA). It treats flows from several Virginia jurisdictions and that portion of the flow from Virginia is counted toward the Virginia point source cap loads. However, the Virginia jurisdictions do not have control of the treatment levels at Blue Plains. DC WASA is facing several daunting capital demands including significant Combined Sewer Overflow work, construction of a new digester complex and ongoing plant upgrades. Blue Plains is currently required to remove nitrogen to an annual average level of 7.5 mg/l. When, and to what extent, improvements for nitrogen removal are implemented is unknown at this time. A capital program to increase nitrogen removal (estimated at \$820 million of which the Virginia share could be \$103 million at Blue Plains may involve a complex negotiation between the Virginia and Maryland jurisdictions served by Blue Plains, the District of Columbia, and the EPA. The Washington Area Council of Governments may take the lead in these negotiations.

The Upper Occoquan Sewage Authority (UOSA) treats flows from portions of Fairfax County, Prince William County, and the Cities of Manassas and Manassas Park. The facility discharges to an unnamed tributary of Bull Run, about 19 stream miles above the Fairfax County Water Authority (FCWA) intake located in the high dam of the Occoquan Reservoir. The reservoir provides drinking water to about 1.2 million residents of Northern Virginia (750,000 in Fairfax County and about 450,000 through wholesale customers). UOSA has one of the most stringent discharge permits in the world. The UOSA permit is unique in that it details operational requirements for the plant dependent on the nitrate level at the FCWA water intake. If nitrate levels approach 5 mg/l, UOSA is required to remove nitrate from its effluent using a denitrification system. Prior to the 5 mg/l drinking water threshold, nitrate is considered beneficial to the overall water quality in the reservoir by helping to trap phosphorus in the sediments. UOSA will continue to be operated primarily to protect the water supply for FCWA customers.

Finally, regional growth in northern Virginia is expected to continue among the highest rates in the Bay watershed. However, growth will not be evenly distributed across the area. In general, the western suburbs are growing at a faster rate than the more developed areas inside the

Beltway. The Potomac Tributary Strategy must find a way to accommodate equity in the handling of divergent growth rates.

Appendix C – Water Quality Status and Trends Maps

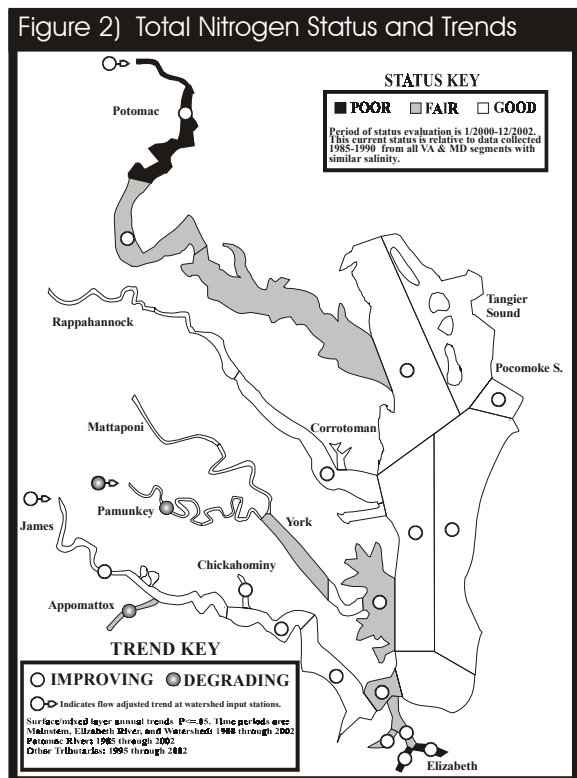
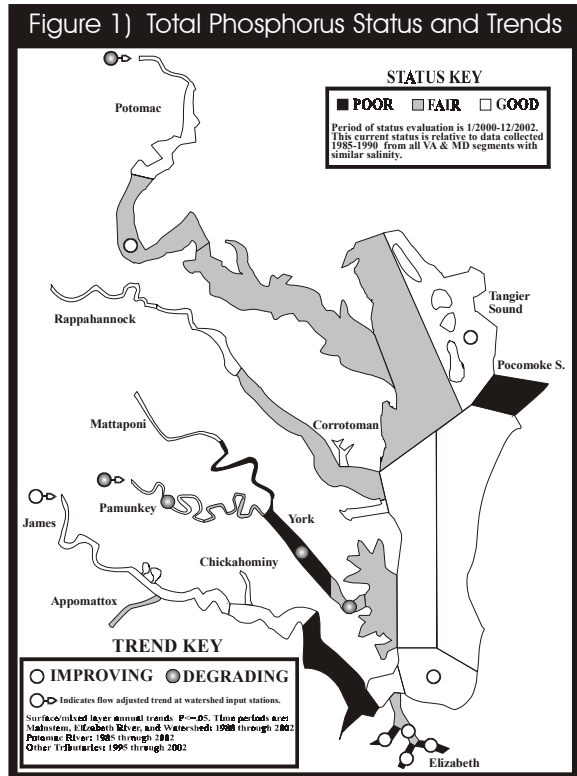


Figure 3) Chlorophyll Status and Trends

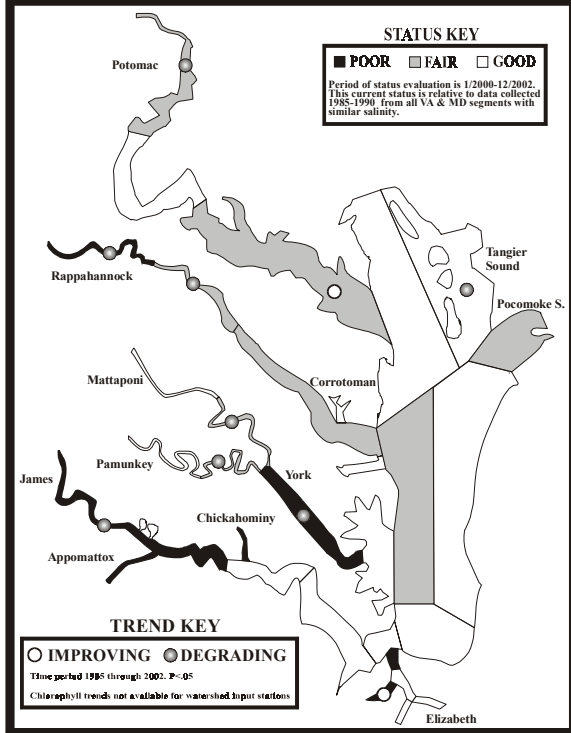


Figure 4) Dissolved Oxygen Status and Trends

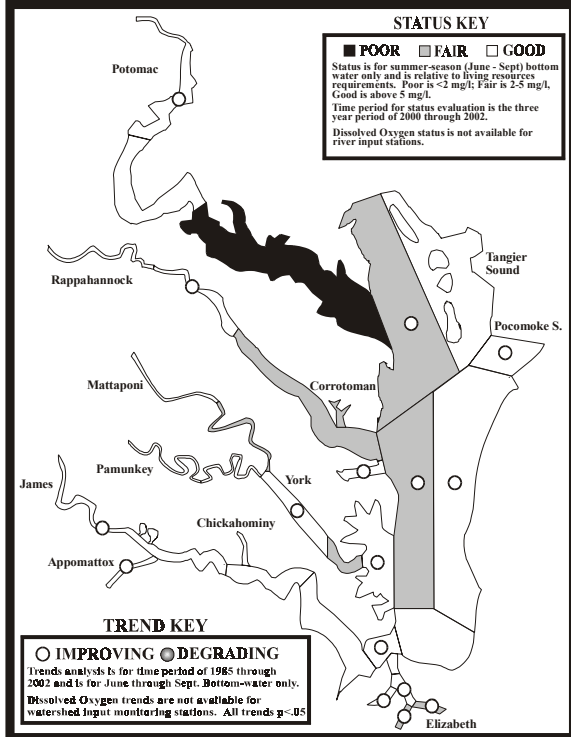


Figure 5) Water Clarity Status and Trends

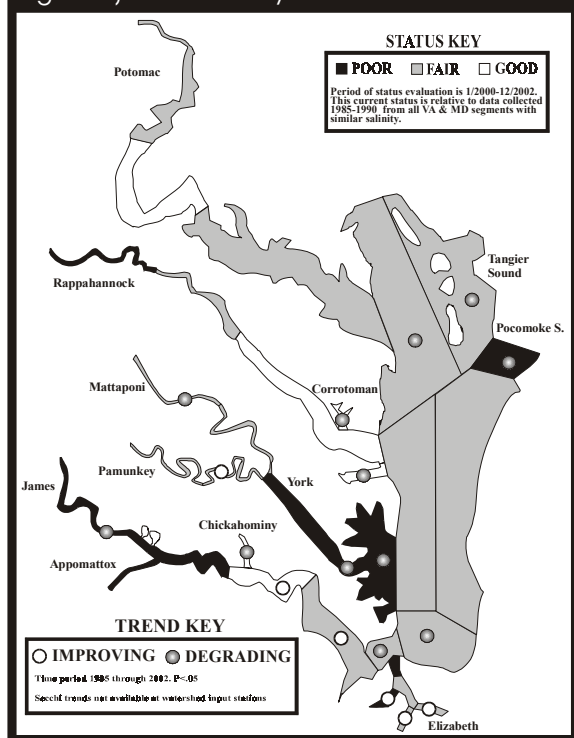
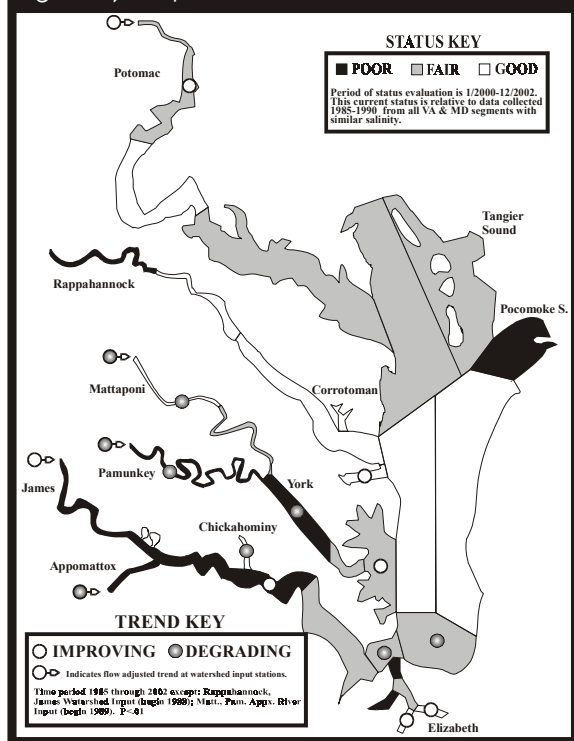
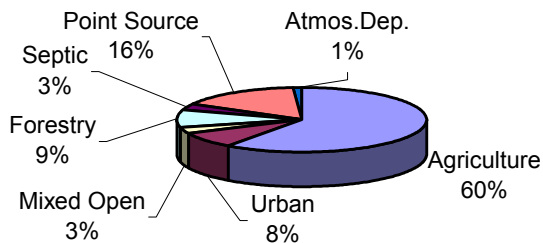


Figure 6) Suspended Solids Status and Trends

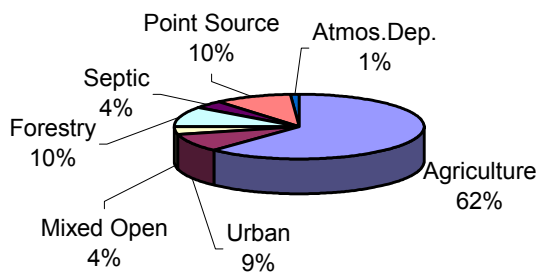


Appendix D – Shenandoah and Potomac Loadings by Land Use 1985-2002

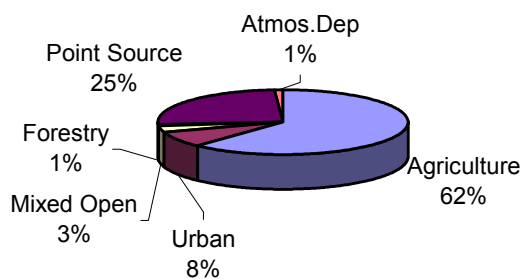
Shenandoah 1985 Percent Nitrogen Loads by Land Use - Total Load = 6,123,385 lbs.



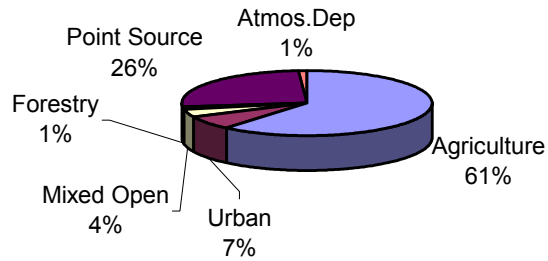
Shenandoah 2002 Percent Nitrogen Loads by Land Use - Total Load = 5,956,651 lbs.



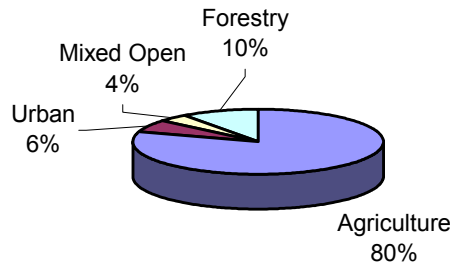
Shenandoah 1985 Percent Phosphorus Loads by Land Use - Total Load = 1,253,442 lbs.



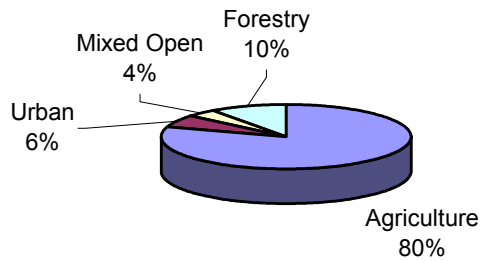
Shenandoah 2002 Percent Phosphorus Loads by Land Use - Total Load = 1,144,112 lbs.



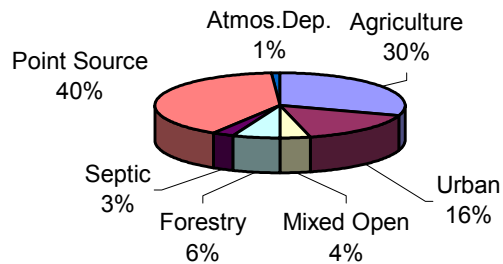
Shenandoah 1985 Percent Sediment Loads by Land Use - Total Load = 504,664 tons



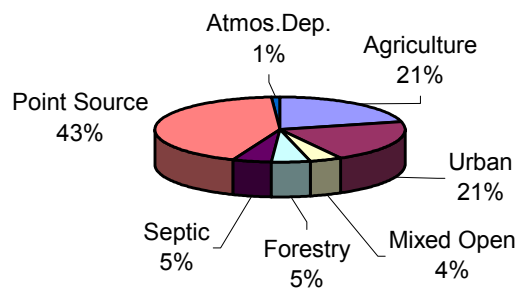
Shenandoah 2002 Percent Sediment Loads by Land Use - Total Load = 457,463 tons



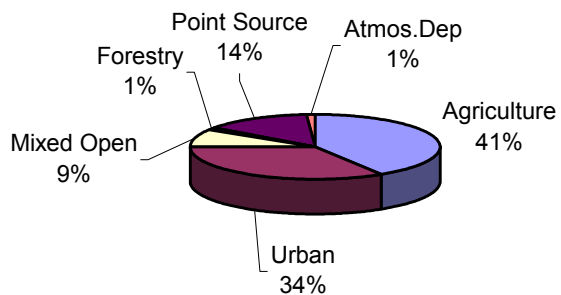
Potomac 1985 Percent Nitrogen Loads by Land Use - Total Load = 17,312,651 lbs.



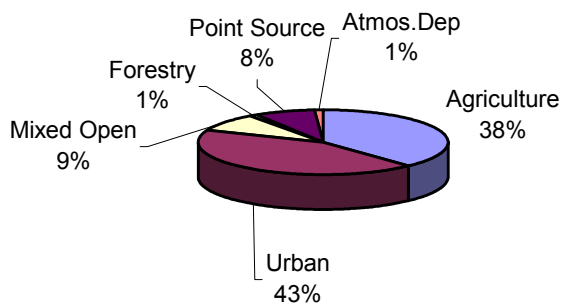
**Potomac 2002 Percent Nitrogen Loads by Land Use -
Total Load = 16,107,370 lbs.**



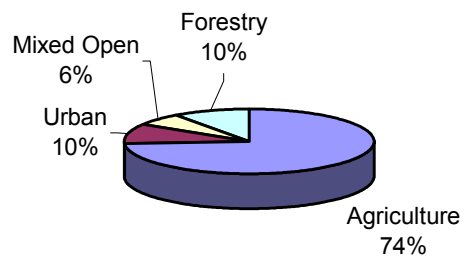
**Potomac 1985 Percent Phosphorus Loads by Land Use -
Total Load = 1,052,303 lbs.**



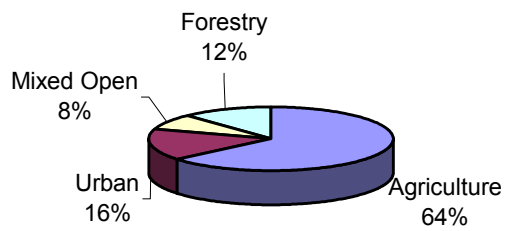
**Potomac 2002 Percent Phosphorus Loads by Land Use -
Total Load = 797,949 lbs.**



**Potomac 1985 Percent Sediment Loads by Land Use -
Total Load = 323,052 tons**



**Potomac 2002 Percent Sediment Loads by Land Use -
Total Load = 262,997 tons**



Appendix E – Strategy Costs by Source Category – Shenandoah and Potomac

Table E-1 . Potomac Summary of Costs By Source Category

Potomac Basin Estimated BMP Cost Summary

Agricultural BMPs	Cost Units	Cost/Unit	Basin Costs
Conservation-Tillage	\$/Acre	\$3	\$0
Forest Buffers	\$/Acre	\$545	\$33,622,907
Wetland Restoration	\$/Acre	\$889	\$5,568,696
Land Retirement	\$/Acre	\$928	\$0
Grass Buffers	\$/Acre	\$175	\$3,810,302
Tree Planting	\$/Acre	\$108	\$1,779,624
Nutrient Management Plans	\$/Acre	\$7	\$331,909
20% Poultry Litter Transport	\$/Wet Ton	\$12	\$0
10% Livestock Manure Transport	\$/Wet Ton	\$12	\$0
Conservation Plans	\$/Acre	\$7	\$1,133,691
Cover Crops (Early-Planting)	\$/Acre	\$19	\$0
Cover Crops (Late-Planting)	\$/Acre	\$19	\$901,740
Off-Stream Watering w/ Fencing	\$/Acre	\$284	\$13,700,292
Off-Stream Watering w/o Fencing	\$/Acre	\$152	\$2,484,136
Off-Stream Watering w/ Fencing & RG	\$/Acre	\$186	\$2,952,857
Stream Stabilization	\$/Acre	\$12	\$0
Animal Waste Management	\$/Acre	\$32,278	\$0
Yield Reserve	\$/Acre	\$30	\$276,420
30% Poultry Phytase	N/A	\$0	\$0
Total Cost for Agricultural BMPs			\$66,562,574

Point Source Reductions	Cost
Phosphorus Reductions	\$6,112,778
Nitrogen Reductions	\$335,949,281
Total Costs for Point Source Reductions	\$342,062,059

Basin Total*	\$756,283,092
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Urban BMPs	Cost Units	Cost/Unit	Basin Costs
Wet Ponds & Wetlands	\$/Acre	\$820	\$56,385,660
Dry Det Ponds & Hyd Struct	\$/Acre	\$820	\$0
Dry Ext Det Ponds	\$/Acre	\$820	\$0
Urban Infiltration Practices	\$/Acre	\$820	\$58,578,750
Urban Filtering Practices	\$/Acre	\$820	\$58,570,960
Urban Stream Rest	\$/Mile	\$63,360	\$0
Urban Forest Buffers	\$/Acre	\$108	\$2,539,404
Urban Tree Planting	\$/Acre	\$108	\$1,693,008
Urban Nutrient Management	\$/Acre	\$15	\$1,256,099
Urban Growth Reduction	\$/Acre	\$22	\$0
Erosion & Sediment Control	\$/Acre	\$2,500	\$60,942,500
Total Cost for Urban BMPs			\$239,966,381

Mixed Open BMPs	Cost Units	Cost/Unit	Basin Costs
Wetland Restoration	\$/Acre	\$889	\$6,923,532
Tree Planting	\$/Acre	\$108	\$1,682,100
Mixed Open Nutrient Management	\$/Acre	\$15	\$992,173
Forest Buffers	\$/Acre	\$545	\$16,976,205
Total Cost for Mixed Open BMPs			\$26,574,010

Forest BMPs	Cost Units	Cost/Unit	Basin Costs
Forest Harvesting Practices	N/A	\$21	\$15,788
Total Costs for Forest BMPs			\$15,788

Septic BMPs	Cost Units	Cost/Unit	Basin Costs
Septic Denitrification	\$/System	\$8,065	\$54,132,280
Septic Pumping	\$/System	\$200	\$10,068,000
Septic Connections	\$/System	\$1,500	\$16,902,000
Total Cost for Septic BMPs			\$81,102,280

*Does not include Technical Assistance

Table E-2. Shenandoah Summary of Costs By Source Category

Shenandoah Basin Estimated BMP Cost Summary

Agricultural BMPs	Cost Units	Cost/Unit	Basin Costs
Conservation-Tillage	\$/Acre	\$3	\$0
Forest Buffers	\$/Acre	\$545	\$31,019,148
Wetland Restoration	\$/Acre	\$889	\$13,141,198
Land Retirement	\$/Acre	\$928	\$0
Grass Buffers	\$/Acre	\$175	\$2,777,393
Tree Planting	\$/Acre	\$108	\$2,780,244
Nutrient Management Plans	\$/Acre	\$7	\$524,663
20% Poultry Litter Transport	\$/Wet Ton	\$12	\$944,484
10% Livestock Manure Transport	\$/Wet Ton	\$12	\$0
Conservation Plans	\$/Acre	\$7	\$2,428,562
Cover Crops (Early-Planting)	\$/Acre	\$19	\$0
Cover Crops (Late-Planting)	\$/Acre	\$19	\$1,299,695
Off-Stream Watering w/ Fencing	\$/Acre	\$284	\$15,262,887
Off-Stream Watering w/o Fencing	\$/Acre	\$152	\$8,405,296
Off-Stream Watering w/ Fencing & RG	\$/Acre	\$186	\$245,662
Stream Stabilization	\$/Acre	\$12	\$0
Animal Waste Management	\$/Acre	\$32,278	\$1,554,170
Yield Reserve	\$/Acre	\$30	\$138,390
30% Poultry Phytase	N/A	\$0	\$0
Total Cost for Agricultural BMPs			\$80,521,791

Point Source Reductions	Cost
Phosphorus Reductions	\$4,780,128
Nitrogen Reductions	\$68,116,802
Total Costs for Point Source Reductions	\$72,896,930

Basin BMP Total*	\$322,884,500
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Urban BMPs	Cost Units	Cost/Unit	Basin Costs
Wet Ponds & Wetlands	\$/Acre	\$820	\$14,753,440
Dry Det Ponds & Hyd Struct	\$/Acre	\$820	\$0
Dry Ext Det Ponds	\$/Acre	\$820	\$0
Urban Infiltration Practices	\$/Acre	\$820	\$14,753,440
Urban Filtering Practices	\$/Acre	\$820	\$14,753,440
Urban Stream Rest	\$/Mile	\$63,360	\$0
Urban Forest Buffers	\$/Acre	\$108	\$792,288
Urban Tree Planting	\$/Acre	\$108	\$528,336
Urban Nutrient Management	\$/Acre	\$15	\$1,218,001
Urban Growth Reduction	\$/Acre	\$22	\$0
Erosion & Sediment Control	\$/Acre	\$2,500	\$56,857,500
Total Cost for Urban BMPs			\$103,656,445

Mixed Open BMPs	Cost Units	Cost/Unit	Basin Costs
Wetland Restoration	\$/Acre	\$889	\$6,746,621
Tree Planting	\$/Acre	\$108	\$819,612
Mixed Open Nutrient Management	\$/Acre	\$15	\$1,476,336
Forest Buffers	\$/Acre	\$545	\$6,203,735
Total Cost for Mixed Open BMPs			\$15,246,304

Forest BMPs	Cost Units	Cost/Unit	Basin Costs
Forest Harvesting Practices	N/A	\$21	\$12,314
Total Costs for Forest BMPs			\$12,314

Septic BMPs	Cost Units	Cost/Unit	Basin Costs
Septic Denitrification	\$/System	\$8,065	\$42,510,615
Septic Pumping	\$/System	\$200	\$7,906,600
Septic Connections	\$/System	\$1,500	\$133,500
Total Cost for Septic BMPs			\$50,550,715

*Does not include Technical Assistance